

PRACTICAL ESTIMATOR

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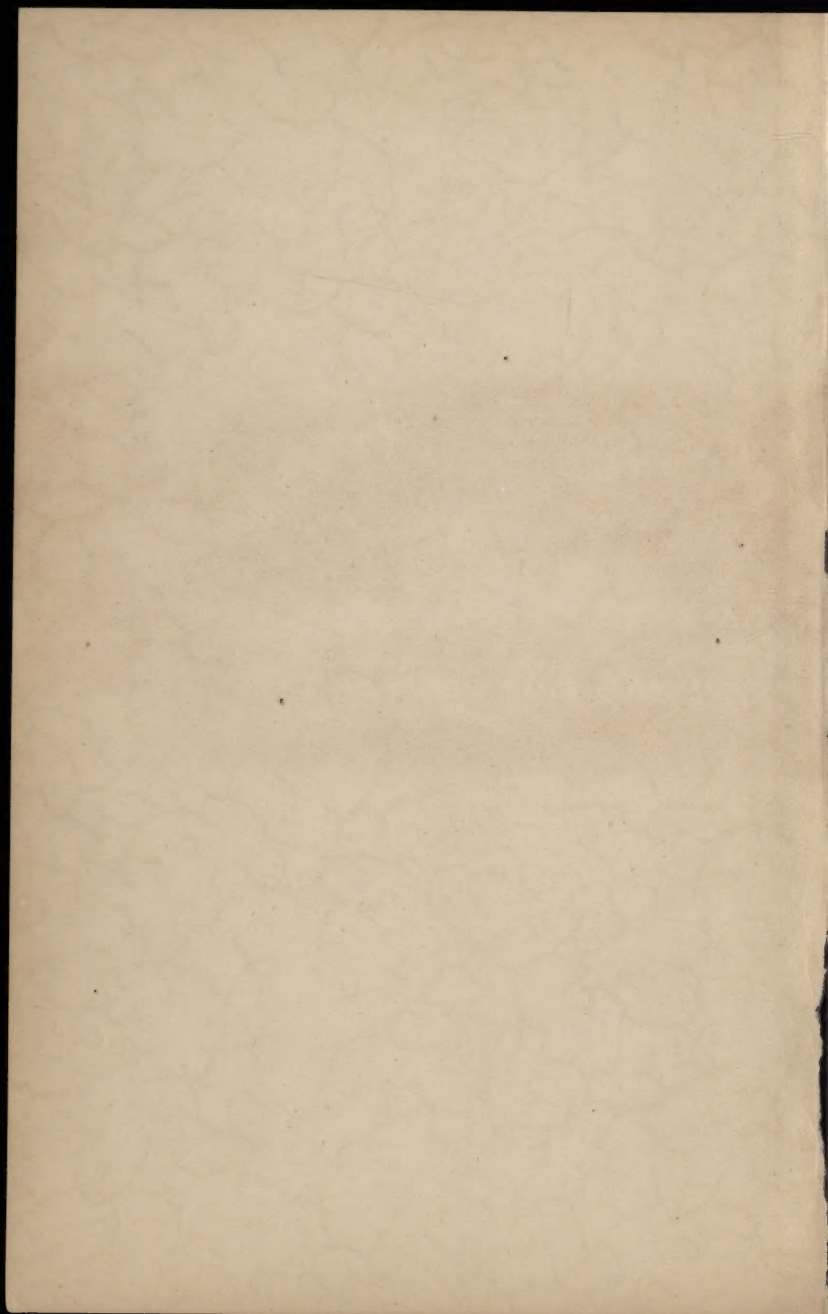
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J. F. STEVENS.

THE
PRACTICAL ESTIMATOR,

WITH A
COMPANION AND KEY

FOR THE
PRACTICE OF ESTIMATING

WORKS OF CONSTRUCTION, AND
FOR THE PURPOSES OF
TEACHING AND EXAMINING
IN THE ART OF ESTIMATING
WORKS OF CONSTRUCTION.

By
J. F. STEVENS, Architect and Builder.

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INTRODUCTION.

The importance of accurate and properly itemized estimates in all contract work is very generally recognized. Yet estimates hastily made and lacking in many essential particulars are very common. The remarkable discrepancies frequently encountered in bids upon work, even between responsible contractors with equal facilities, is largely attributable to faulty estimating, while the same cause accounts for numerous failures in the building trades. It is easy enough to charge the responsibility of failure and loss to inaccurate estimates, but until mechanics are furnished with some standard of valuation, or with some means of learning the art of estimating besides that of individual judgment, no important improvement can be expected. At present, in the absence of any adequate apprentice system, and for lack of a competent master to examine and criticise the first efforts of the novice at estimating, builders are compelled to gain their experience in the most expensive school, and the errors of judgment incident to all first efforts are paid out of capital. Enough new men are constantly entering the ranks to keep prices in an unsettled and uncertain condition,

and hence a very unsatisfactory state of affairs prevails. This is the subject of frequent comment by experienced builders, who feel the embarrassment of it, and is often discussed in the building and mechanical journals. At some future time, when our industries have become older, a school of estimating may be established in which the art, in all its intricacies, will be taught by competent instructors. When this stage has been reached builders will be justified in establishing and enforcing rules looking to the exclusion from the business of all who cannot pass a creditable examination in this important part of their work; but until such a happy period arrives, the best that can be done is to encourage careful and systematic individual effort. It is in the desire to aid in this direction that this little work and the "Handy Estimate Blanks," which it accompanies, have been prepared.

A careful examination of the work of preparing an ordinary estimate, under the circumstances usually attending such work, reveals some of the deficiencies of the usual plan pursued, and shows wherein such an assistant as this little book may be very serviceable. The first thing that strikes the observer is the drudgery of the work and the constant tension of mind necessary to recollect little things and place these items in proper place, while also attending to the more important matters of construction and materials. Much of the work of making an estimate is pure routine—in other words,

what may be called machine work—but, in the absence of adequate machinery for performing it, it is done in an expensive manner, and frequently in a very bungling way. Another important fact revealed to any one who examines into the work of estimating, as commonly performed, is that there is seldom any time specially set apart for this work, and that it is performed at odd hours, when other engagements will permit, or occasionally in spite of other duties, because the estimate is demanded at that particular time. Interruptions are the rule, and it is seldom that undivided attention can be given to the work. In the case of very important jobs, evenings are sometimes devoted to the work; but if the contract is unusually large or intricate one evening seldom suffices, so there is the necessity of taking up the work upon a future occasion where it was dropped on the first. The difficulty of resuming work of this kind after an interruption, either longer or shorter, is well known and appreciated by every one who has had experience in estimating.

It is believed that the routine work above alluded to will be satisfactorily performed by the "Handy Estimate Blanks," and by the list of items which this volume contains, when used as a reminder. Whenever the builder who uses these aids has become convinced that all the items he should take into account are listed in them, he will not be disconcerted by interruptions, for the printed forms will relieve his memory of the necessity of recol-

lecting what he has already listed and what remains to be done. When work is laid aside at night, to be taken up in the morning or at some other time in the future, the mind will be similarly at rest about the point at which it is to be resumed. In addition to this, it is believed that the same helps will insure against the omission of items, which occurs occasionally under the most favorable circumstances. They will also systematize the method of preparing estimates and the filing of them in a way that will make references not only easy, but of the greatest possible advantage.

Were it necessary to produce arguments in favor of the use of blanks in the work of estimating, the mere mention of the fact that blanks are in regular use by many of the most prominent and most successful contracting firms in the country would probably be sufficient. Firms which do a large business are in a position to employ every possible aid to system and accuracy, and with many of them the regular employment of estimate blanks is as much a matter of course as the use of printed letter-heads, bill-heads and other forms of office stationery. The forms which they employ are generally the outgrowth of their own experience, and often are jealously guarded for fear some competitor may have the opportunity of copying features which in practice have been found to afford advantages. The small contractor, the sum total of whose annual business is perhaps two or three medium-priced dwellings, a store building and one or two

stables, with the usual run of small jobs of repairing, has no opportunity of systematizing his business upon a corresponding basis, because he has neither the experience necessary nor the bulk of trade required to make the introduction of a carefully-considered system of his own profitable. The small contractors, taken as a class, probably do the larger share of the entire building business of the country, from which it will be seen that whatever advantages are at present derived from blanks and other features of thorough system are applicable only to the smaller part of the business. The attempt is made in the "Handy Estimate Blanks" to bring at least a share of these advantages within the reach of contractors doing business upon an ordinary basis. The plan upon which they are arranged, therefore, is such as to adapt them particularly to the use of builders doing a moderate business and whose contracts are for the most part confined to the ordinary run of buildings.

Besides the direct help in the work of estimating which this little book contains, there will also be found a selection of tables and rules useful in the calculations incident to making estimates. Some tables very commonly used are given in the estimate blanks, and are not repeated here. In the selection, care has been exercised to present such as are the most useful, and to give as many as are really serviceable, always remembering that the book swelled to undue proportions would defeat its own purpose.

HOW TO PREPARE AN ESTIMATE.

SHOWING IN DETAIL THE USE OF THE
"HANDY ESTIMATE BLANKS."

The work of preparing a correct estimate upon a building to be erected according to plans and specifications is essentially the same in character, whether the "Handy Estimate Blanks" are employed or not. The labor in the former case, however, is much less than in the latter. The first requisite is a clear comprehension of what is to be done, and the manner in which it is to be performed. These points are to be gained from a careful inspection of the drawings and specifications. Since these form a part of the contract, in case a contract is made, it becomes important that the builder make a record of what he bases his figures upon, in order to be saved the injustice of changes in drawings, which in some instances are made between the time he inspected them for making his estimate and the commencement of the work. Changes in the drawings themselves are not so frequent as additional or explanatory drawings, which, although commonly provided for in the specifications, and ostensibly representing the work as it was originally contemplated, often become matters of dispute and misunderstanding between owner and contractor.

To facilitate this, the first pages of the covers of the "Handy Estimate Blanks" are arranged in such a way as to make it easy to record all necessary particulars with reference to original drawings and specifications. In the upper part of the page a line is left for the insertion of the date at which the estimate is made, and its number, the latter for use in case the estimates are filed by number. Following is the name of the building and its location, the name and address of the architect, the name and address of the owner, and the name of the person for whom the estimate is especially made. The latter, in many cases, would be filled out by simply inserting "owner," thus intimating that the contract, if made, is to be made at first hand, and not through an agent. In the following space lines are provided for an enumeration of the drawings and other data upon which the estimate is based. By making a list of the drawings submitted at the time of estimating, the builder has a record with which to compare such drawings as are furnished him by which to execute the work, and thus ascertain what additions, if any, have been made. It is believed that the labor of filling out this list is too small an item to be counted as an objection, for the builder would commence his work by listing the drawings, and would accomplish it and become familiar with what is really to be done at one and the same time. The listing of the drawings also serves to fix them in the mind. The benefit to be derived from this feature of the

blanks is more apparent in a business where a large number of estimates are made, and where of necessity the written record must be depended upon, than in a small business where so few estimates are made as to prove no serious tax on the memory to recall such matters. There will always be an advantage, however, in a written record over the unaided memory.

Among other items of information which a builder should consider at the time of making the estimate on a given piece of work, and which sometimes are contained in the specification, and in some cases are conveyed by mere verbal explanation, are the time at which the work is to be executed and the terms of payment proposed. These things sometimes influence his prices. It is always well for him, when possible to do so, to visit the site of the proposed building, in order to determine if any unusual difficulties in excavating and grading are likely to be encountered. Still other items of miscellaneous information may come up at the time the estimate is made of which it is desirable to keep a record. Provision for the matters we have specifically described, and also for others, is made on the second page of the cover of the blanks, in the upper division.

When a proposal is made it is essential that a copy or other definite record of its terms and amount shall be kept. A convenient method of keeping such a record is filling out the blank furnished in the middle division of the second page of

cover. After the proposals of the several bidders are opened and the contract has been awarded, a comparison of figures is often made between competitors. Sometimes the results of the letting are published officially, showing in detail the different bids that were received. Comparisons of figures, however made, are always of interest, but to be of the greatest advantage they should be recorded and carefully studied at leisure. In view of these remarks the blank form at the bottom of the second cover page becomes apparent. It affords a convenient means of recording competitors' figures, whenever they can be obtained, in a manner to be serviceable for study. One of the first requisites in the successful prosecution of any business is a knowledge of one's competitors. By systematically recording and examining competing figures in this way through a single season's business, it is believed that such a knowledge of competitors' methods of estimating, as well as their prices, will be obtained as to make it almost possible to determine where their figures will be in advance of a letting. Such information is frequently of the greatest value, inasmuch as it may permit of a better profit being obtained at times when, without it, the contractor would feel constrained to keep his figures down to low-water mark. As long as the practice of awarding contracts to the lowest bidder continues to prevail there will be but little chance of builders obtaining anything but a minimum of profit, unless their competition is carefully studied and advantage

taken of circumstances in the general way we have described.

The work of the estimate proper is commenced on the third page of the blanks. The various items composing the mason work of an ordinary building are first presented, together with some blank spaces for the insertion of any additional items which the special requirements of the neighborhood may make necessary. Commencing on page 8, the carpenter work is similarly presented. This latter division is made to include painting, tinning, slating and galvanized-iron work, plumbing and gas-fitting. The carpenter is ordinarily required to include these in his proposal. Sometimes he makes his own estimate upon them, and sometimes he depends upon sub-contractors. In either case, the blanks provided under these heads may be used to record the figures reached. A few blank spaces are left in this division of the book for any parts of carpentry which special construction or design may make necessary.

The arrangement of the several blank spaces for extensions and insertion of items is the same throughout the book. The general division of the work being considered is printed in the column at the left, the words running lengthwise of the page. Each of these headings is also numbered, thus facilitating references to and from the general summary further on in the book. Some of the items entering into the work described by the general head, and such as are common to buildings in gen-

eral, are printed in the blank, while lines for the insertion of any additional items found necessary are provided below. The first vertical column affords space for estimated quantities. Next come the items, following which is a column for prices, and then one for extensions of estimated costs. Here the estimate ends, the remaining three columns being provided for a record of actual cost of the same items, thus facilitating a comparison between estimated cost and the real value of the work.

The importance of systematic comparison in this way is hardly to be overvalued. There is no royal road to estimating. While the work of taking off quantities from drawings can be reduced to a system and a high degree of accuracy attained, there is scarcely anything but judgment to govern the estimator in the matter of the prices put upon the different items. After he has recorded his judgment in this matter, it is of the highest importance, in view of other estimates yet to be made, that its accuracy should be verified. If he is correct, it is a satisfaction to be assured of the fact, while if his judgment is in error on any item, however insignificant, it is desirable that he know it in order not to be misled in subsequent work.

To fill out the last three columns in these blanks systematically on every job is hardly to be contemplated, for the amount of clerical work involved would be greater than any builder ordinarily situated could afford. But occasionally experiments

of this kind can be made, and enough done in regular course to keep a wholesome check on estimating. Very often the actual cost of some portion of a contract comes up for attention, whether special effort has been made to keep track of it or not. A place to record such items is all that is necessary to render such information of real and permanent value in business. By providing columns for "Actual Quantities," "Actual Price" and "Actual Cost," opportunity is afforded for recording cost in a systematic manner, or at convenience in fragmentary portions, as the builder may desire. Thus the cost column can be readily filled out from the bills of the purchased material for many of the items, and in some instances the quantities can be inserted in the same manner. The arrangement of the columns is such that records of this kind may be kept in them in almost any manner desired.

A line for "Allowances and Profits" is provided in each of the divisions, below which is a space for footings. The selling price of each of the parts of the work enumerated may in this way be determined in detail, and then entered in the general summary; or these lines may be disregarded and the net cost of the items entered on the summary, to the footings of which "Allowances and Profits" may be added in gross. Just which of these two plans is best to pursue depends somewhat upon circumstances and the general preferences of the estimator. Where allowances and profits are calculated upon a definite percentage there will be

but little difficulty in figuring each general division of the work upon an independent basis, thus affording a correct foundation for comparison with actual cost, and facilitating any calculations necessary to be made on account of alterations in the work. The old rule of every tub standing upon its own bottom is applicable in estimating, both in matters of the kind just described and in making each item, however listed, stand for itself without reference to anything else which may be presumed to be listed either a little too high or too low.

The general scheme of using the "Handy Estimate Blanks" is to make computations on loose sheets of paper and to record the results of such calculations opposite the proper items in the blank form. By this means only so much of the estimate will be preserved as it is desirable to keep. Estimating at actual cost of materials and labor, and then adding for profits upon the basis of a definite percentage, is the plan recommended, because it is believed to be the best on account of rendering a variation of profit easily made when circumstances demand it, and because it always keeps before both estimator and builder, when these are different persons, the actual value of things. Fluctuations in the markets of both materials and labor, it is believed, are more easily recognized in this manner than in any other, and variations of this kind are constantly occurring. However, the blanks will also be found useful for those who prefer estimating in any other way. Such general

directions as we shall present, however, have reference to the first method.

In arrangement, the blanks for the most part have been made to follow the same order that would be pursued in the erection of the building. Thus, Masonry is placed before Carpentry, and in the latter part of Carpentry are placed such items as painting, plumbing, &c., which, ordinarily, are about the last that are supplied to a building. The first item in Masonry is "Preliminary Work," followed by "Excavating." The first under the head of Carpentry is the "Frame," following which, in proper order, are "Frame Covering," "Gable Covering," "Roof," "Cornice," &c. As already mentioned, blank spaces are left at the close of both Masonry and Carpentry for the insertion of any divisions of work peculiar to a given job, or which the building practice of the neighborhood makes necessary. Following Carpentry, a page is devoted to "Recapitulation," which may be filled out in either of the two ways, so far as relates to profits allowed, as we have already described; or this page may be omitted, and if that form of reaching totals is preferred, the several pages of the estimate may be footed in the usual manner, amounts from the bottom of each page being carried forward to the top of the next for adding in. It is believed, however, that the analysis of the work produced by following the divisions of the blank and transferring the several footings of these divisions to the recapitulation page is the best. The close inspection of each

portion of the work which this method insures will be so great a safeguard against mistakes in the way of undervaluation or overvaluation as to fully warrant the small additional labor which it may seem to involve.

Following the page devoted to recapitulation is a page appropriately ruled and printed for recording the principal dimensions of the building. In many instances the estimator will facilitate his work by filling out this page as the first step in preparing an estimate. In others this page will be filled out by degrees, as the several quantities are reached in the regular progress of the estimate. The object of this page is to record dimensions and quantities of recurring use, when once obtained, in such a manner as to make them convenient for reference, so that once measuring a given portion of the drawings will answer for all. For this reason it would seem desirable to fill it out complete at the commencement. To make it of the greatest convenience in use, this page, instead of being on a regular leaf of the blank, is on the outer end of a folded leaf placed near the end of the book. By this means it is easily spread out to the right, in such a way as to be opposite each of the several pages where quantities are required. Accordingly, the estimator has always before him the general dimensions of the structure, with many other similar items, which serve to facilitate his work, and which also serve as a check upon his calculations in general.

A use to which the page of general dimensions

may be put is that of facilitating hasty estimates on similar buildings to the one already erected. It contains the number of rooms, number of doors and windows, and principal dimensions of the building items, which, for purposes of comparison, are of the greatest importance. With these items before him, and knowing the exact cost of a building already finished, the builder can make a guess as to the cost of a proposed building somewhat resembling it sufficiently close for the purposes of preliminary estimates as ordinarily made.

Upon the opposite side of this folded sheet, which is creased in such a manner as to be turned in between any of the pages which precede it, there is given a timber table, arranged in such a manner as to be convenient for use in making various calculations necessary in estimating the framework of the building. Several other tables of similar usefulness and convenience are given upon the same page.

After a contract is obtained and the work is about to be commenced, one of the important things to do is to order the timber required for the building. The estimate, if it has been correctly made, furnishes all necessary data from which to prepare a schedule of the items required. On the remainder of the broad, folded page which we have just been describing, is printed a schedule form for the various pieces of timber necessary. The column to the left shows the parts of the house to which the several pieces belong, while along the

top the building is subdivided into Main House, Right and Left Wing and Extension, thus definitely locating each piece of timber and placing a complete check upon the calculations made in the process of filling out this blank. Opposite each general kind of timber mentioned are two spaces for size, which are to be filled out in the usual manner, as "6 x 8" or "8 x 10." Spaces for four different lengths, and the number of pieces required of each, are opposite each of these dimension spaces. These are to be filled out thus: " $2/_{20}$ "—meaning 2 pieces 20 feet long of the dimensions opposite. While it is believed the enumeration of items is sufficiently extended to meet all ordinary requirements, some blank spaces are left for any additions that may be found necessary, while substitution of items that are required for some of those printed in the form not required, by the simple plan of erasure and writing in, will adapt the blank to almost any case that may arise in common practice.

The use of such a schedule of timber is three-fold. It becomes a desirable part of the records of an estimate and contract, and should therefore remain a permanent part of the estimate. It forms an intelligent basis for the order to the yard or mill from which the material is to be obtained, or it may constitute the order itself; and it serves to convey to the managing foreman of the job the ideas of the estimator, or the managing man under whose directions it has been filled out, as to the cutting of the timber and the use for which each particular

piece has been intended. The waste of timber incident to bill stuff being worked into a building upon some other plan than that upon which it was intended to be used is well known to builders. Loss of this kind is sure to occur unless adequate means exist for showing how the material has been calculated. Another source of loss is the occasional failure of the yard or mill to supply all that is ordered and charged for, a mistake not ordinarily detected, as things are commonly managed, until the missing pieces are required for use, which sometimes is so long after the delivery of the material as to leave a doubt whether it has been an omission or a theft subsequently committed by some one, or whether the pieces in question have not been used for other purposes.

To meet all these requirements the schedule of timber is furnished in the blanks in duplicate, one copy being perforated for tearing out. The intent is that the original shall be filled out as we have described, and then the duplicate filled from it. The duplicate may first be sent to the yard or mill from which the material is being ordered as the order, putting upon the party supplying the timber the responsibility of correct transcription in such form as suits his own order-book. It may then go to the managing foreman in charge of the work. By it he is able to check the several items of timber as they are delivered, and to sort them into such lots as may seem to him best suited to the framing work which is to be done. He learns from it just where

each particular piece which has been sent him is intended to be used, and is thereby left no excuse for such mistakes as cutting in two a long timber to make some shorter ones, thus providing the necessity of ordering an additional long piece, and having left on hand the short pieces which were not used at the outset from oversight. This duplicate in the hands of the foreman also becomes a basis of conference between the builder and foreman in various matters of construction and management. For such special directions as the builder may desire to give, either to the lumber yard or mill or to the foreman, the back of the duplicate schedule is ruled in faint lines for writing. The original schedule remaining with the estimate and in the possession of the builder, or in the office in case of a contracting firm, becomes the basis by which invoices of material furnished to the building in question are checked.

From these explanations and directions it will be seen that the endeavor throughout the "Handy Estimate Blanks" has been to link together as closely as possible the estimated cost of a piece of work with the actual cost of performing the same. It is our belief that the closer this intimacy can be maintained, and the more frequently comparisons are made, the more accurate estimates will become. It frequently happens that a builder estimates some portion of work common to numerous buildings either too high or too low as an habitual practice. Without any regular means of compari-

son of estimated cost with actual cost, this error may be repeated many times before it is discovered and corrected. A tendency to such mistakes as this will be removed if the study of the contract price in view of actual cost is pursued in the manner which the arrangement of the "Handy Estimate Blanks" makes both possible and convenient.

In the use of the "Handy Estimate Blanks" it is expected that this little book will be used as a companion. For this reason it has been made of convenient size for carrying in the pocket. Various blank spaces have been left in it, which the individual estimators who employ it are invited to fill out for themselves. By additions and modifications of this kind it will become far better adapted to their needs than would otherwise be possible. The one part which will have the most regular and constant use is the list of items, intended as a reminder of what is to be listed in estimating the different portions of a building. A common name applied to such lists, in whatever department of business they are used, is "Tickler"—in other words, something which tickles or jogs the memory. While this "Tickler" has been made as complete as possible, in view of the construction of ordinary buildings in one particular section of the country, it is admitted to have numerous shortcomings, particularly when tested by work of a little different character from that specially in mind during its preparation. For this reason a few blank lines are left in each division, and spaces for some

new divisions are provided, which estimators will fill out as required by the construction peculiar to the neighborhood in which they work, or as demanded by their own preferences, or to supply any omissions which may be discovered to exist in the original work.

It was the remark of a noted engineer, in the introduction to a pocket-book of tables, rules and formulæ for engineers' use, which he published some years since, that by rights every engineer ought to prepare his own pocket-book ; in other words, that the particular selection of rules and tables which an engineer would make in gathering for himself such information as is necessary to the successful prosecution of his business would be better adapted to his needs than any compilation, however perfect and complete, made by some one else. The same principle, we believe, holds good in the work of estimating. By rights each estimator ought to prepare his own estimate blanks and his own "Tickler." But since many are unable to do this, and many more, who are perhaps able, have not the opportunity or cannot afford the expense, the next best thing is to furnish them with such forms as are calculated to meet their requirements, with provisions for alterations and amendments.

By following the plan of adding to and changing above suggested, the "Tickler" in a short time will become individual in its characteristics, just as a well-kept machine, to which slight improvements as

suggested by experience are added from time to time, becomes far more useful to its owner than a new machine of the same class taken directly out of the manufacturer's wareroom. In the publication of the plan of estimating embodied in this little volume, and the estimate blanks which it accompanies, there has been no desire to compel all who make use of any of its features to use every one of them. On the other hand, the intention has been to allow the greatest freedom of individual preference possible under the circumstances. The desire has been to help each estimator where he specially needs assistance, and to make it possible for him to frame his own system, which in many cases will be a happy union of the best features of the plan he has been using and some of the ideas here suggested. We have no doubt that some will find the "Tickler" alone useful, it being the one thing necessary to render their present plan of work entirely satisfactory. Our advice to every one, therefore, is, "Prove all things ; hold fast that which is good."

For the most part in their order of arrangement the divisions in the "Handy Estimate Blanks" and in the "Tickler" agree. There are several exceptions to this general rule, however. For example, in "Plumbing," in the "Tickler" the various parts of work used in an ordinary building are enumerated in the form of division headings or titles, while the items composing them are listed in detail under each. In the "Estimate Blanks," "Plumbing" is restricted to a single division, the items of which are

the division titles in the "Tickler." The purpose of this arrangement has been to make the "Tickler" as complete as possible, while, on the other hand, "Plumbing," being a portion of work seldom figured by a builder without the assistance of a sub-contractor, it has been deemed expedient to keep the blanks as small as possible. The same remarks in general will explain other discrepancies between the "Handy Estimate Blanks" and the list of items in this book.

Since painting is based upon superficial areas, the items of "Painting" will be found in the list given herewith in all the various divisions of the carpenter work which require painting. In the printed form in the "Estimate Blanks" corresponding items do not appear, for the reason that it is not intended that the painting be extended with the carpenter work, but rather gathered together on the one form especially devoted to painting. The object of distributing painting in this manner through the carpenter work in the list of items is to call attention to it at all times when the quantities upon which it is based are before the estimator. Where carpenters figure their own painting, without the assistance of a sub-contractor, this method of proceeding will be found a great saving of labor.

If the use of the "Handy Estimate Blanks"—very brief directions for which are given above—shall result in causing builders to examine into the elements of cost of the structures under their charge more carefully than ever before, the most

important object to be attained by their publication will be accomplished. Much money is lost every year in the building business by careless and insufficient estimating that we are persuaded might be saved if even a part of the care were taken which the use of these forms will insure. It is in the hope that the "Handy Estimate Blanks" may be serviceable, both in facilitating estimates that may be made with their use and in suggestions to those who prefer to construct their own forms, that they are submitted for the consideration of all who have estimating to do.

CLASSIFIED LIST OF ITEMS
ENTERING INTO THE
CONSTRUCTION OF ORDINARY BUILDINGS,
ARRANGED FOR USE AS A
REMINDER OR "TICKLER"
IN PREPARING ESTIMATES.

MASONRY.

Preliminary.

Engineer's services.
Staking out.

Sheds and tool house.
Lumber in profiles.

Excavation.

Sod and loam.
Cellar.
Areas and hatchways.
Piers, (outside.)
Cesspool.
Catch-basin.
Privy.
Drains.

Trenches :
Inclosing walls.
Partition walls.
Chimneys.
Inside piers.
Area walls.
Hatchway walls.

Footings.

Inclosing walls.
Partition walls.

Area walls.
Chimneys.

Footings (Continued).

Inside piers.	Cement.
Outside piers.	Concrete.
Area.	Sand.
Hatchway	Labor.
_____	_____
_____	_____
_____	_____

Underpinning.

Plain stonework.	Cement.
Dressed stonework.	Sand.
Brickwork.	Labor.
Lime.	_____
_____	_____
_____	_____

Foundations.

Stonework in inclosing walls.	Brickwork in partition walls.
Brickwork in inclosing walls.	Lime.
Stonework in partition walls.	Cement.
	Sand.
	Labor.
_____	_____
_____	_____
_____	_____

Cellar Windows.

Sills.	Lime.
Caps.	Cement.
Jambs.	Sand
Iron grates.	Labor.

Hatchway or Area.

Stonework.	Risers.
Brickwork.	Ironwork.
Coping.	Lime.
Door sills.	Sand.
Door caps.	Cement.
Jambs.	Labor.
Steps.	

Drains.

Roof drains.	Washbowl drains.
Cesspool drains.	Elbows, T's and Y's.
Cistern drains.	Connections.
Sink drains.	Traps.
Closet drains.	Cement.
Laundry drains.	Labor.
Bath drains.	

Piers and Partitions.

Brickwork.	Lime.
Stonework.	Cement.
Bond stones.	Sand.
Pier caps.	Labor.

Chimneys, Mantels and Grates.

Brickwork.	Stone hearths.
Stonework.	Brick hearths.
Hearth foundations.	Tile hearths.
Trimmer arches.	Marble mantels.
Jambs.	Slate mantels.
Lintels.	Terra-cotta mantels.
Fire-place openings.	Brick mantels.
Grate openings.	Grates.
Chimney caps.	Grate setting.
Plastering chimneys.	Range setting.
Stove-pipe collars and covers.	Furnace setting.
Ventilators.	Lime.
Ventilator chords.	Cement.
Registers.	Sand.
Iron doors.	Labor.

Cellar Bottom.

Concrete :	Furnace foundations.
Broken stone.	Rat-proofing.
Sand.	Flagging.
Gravel.	Lime.
Paving :	Cement.
Brick.	Sand.
Sand.	Labor.
Cement.	

Cistern and Catch Basin.

Brickwork.	Drain Connection.
Stonework.	Cement.
Flagging.	Sand.
Cover.	Labor.
Overflow.	

Cesspool.

Stonework.	Ventilators.
Brick dome.	Cement.
Flagging.	Sand.
Cover.	Labor.
Drain connections.	

Lathing and Plastering.

Lath.	Two-coat and hard-fin-
Lime.	ish.
Sand.	Stucco cornices.
Hair.	Stucco brackets.
Plaster-of-Paris.	Stucco arches.
Nails.	Stucco centers.
Labor.	Deafening.
One-coat work.	Back plastering.
One-coat and browning.	

Miscellaneous.

Heating building.	Insurance.
Cleaning out.	Whitewashing.

CARPENTRY.

Frame.

Girders in cellar.	Common rafters.
Sills.	Hip rafters.
Cross sills.	Valley rafters.
Posts.	Purlins.
Beams.	Furrings.
Girts.	Ridge pole.
Studs.	Collar beams.
Plates.	Lintels.
Deck plates.	Framing pins.
Tower plates.	Scaffold poles.
Braces.	Stay lath.
Joists, basement.	Ironwork.
Joists, first story.	Rods and bolts.
Joists, second story.	Nails and spikes.
Joists, third story.	Labor framing.
Joists, attic story.	Labor raising frame.
Headers.	Cartage.
Trimmers.	

Frame Covering.

Sheeting lumber.	Moldings.
Sheeting paper.	Clapboarding.
Staging lumber.	Siding.
Base.	Nails.
Corner boards.	Labor.
Casings.	Cartage.
Bands.	Painting.

Gable Covering.

Rough lumber.	Braces.
Millwork.	Finials.
Ornamental boarding.	Ironwork.
Paper.	Nails.
Battens.	Labor.
Gable stuff.	Cartage.
Verge boards.	Painting.
Brackets.	

Roof.

Sheeting lumber.	Hip tins or moldings.
Paper.	Ridging or ridge boards.
Shingling tins.	Covering, shingles, tin,
Chimney flashings.	slate, &c.
Valley and gutter lin-	Nails.
ings.	Gutter strips.

Roof (Continued.)

Cresting.	Cartage.
Ironwork.	Painting.
Labor.	

Cornice.

Cornice blocks.	Frieze trimmings.
Frieze.	Gutter furring.
Bed molding.	Gutter lining.
Planceer.	Millwork.
Fascia.	Nails.
Crown molding.	Labor.
Brackets.	Cartage.
Frieze ornaments.	Painting.
Frieze windows.	

Scuttle.

Scuttle curbing.	Ladder.
Scuttle cover.	Nails and screws.
Hinges and hooks.	Labor.
Tin flashings and covering.	Cartage.
Skylight.	Painting.

Veranda.

Sills.	Furrings.
Posts.	Posts under sill.
Plates.	Flooring.
Floor joists.	Roof covering—slate,
Ceiling joists.	tin, shingles, &c.
Rafters.	Shingling tins.
Roof boards.	Flashings.
Paper.	Ridge and hip tins.
Cornice.	Cresting.
Friezework.	Millwork.
Railing.	Brackets.
Balusters.	Gutters.
Posts to steps.	Moldings.
Rail to steps.	Ironwork.
Finished posts.	Nails and spikes.
Latticework.	Labor.
Steps.	Cartage.
Ceiling.	Painting.
Cant boards.	

Cellar Hatchway.

Door frame.	Nails and screws.
Inside doors.	Ironwork.
Outside doors.	Hinges.
Outside door frame.	Fastenings.

Cellar Hatchway (Continued.)

Locks.	Cartage.
Bolts.	Painting.
Labor.	

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Windows.

Jambs.	Surbase.
Outside casings.	Panel backs.
Moldings.	Grounds.
Caps.	Sash and glass.
Corbels.	Nails.
Foot brackets.	Screws.
Sills.	Weights.
Sub-sills.	Cords.
Outside blinds.	Pulleys.
Trimmings for outside blinds.	Sash fastenings.
Inside casings.	Inside blinds.
Inside moldings.	Trimmings for inside blinds.
Back moldings.	Screens.
Window stops.	Labor.
Stool caps.	Cartage.
Plinths.	Painting.
Corner blocks.	

Dormer Windows.

Studding.	Window sills.
Rafters.	Inside casings.
Plates.	Moldings.
Joists.	Surbase.
Flashings.	Stool cap.
Roof-boards and sheet- ing.	Stops.
Paper.	Sash and glass.
Roof covering—slate, tin, shingles, &c.	Blinds.
Cornice.	Blind trimmings.
Brackets.	Nails and screws.
Foot brackets.	Pulleys.
Millwork.	Weights.
Clapboarding and siding.	Cord.
Casings and jambs.	Screens.
Grounds.	Labor.
	Cartage.
	Painting.

Cellar Windows.

Frame.	Fastenings.
Casing.	Screens.
Sash and glass.	Iron gratings.
Moldings.	Labor.
Nails and screws.	Cartage.
Hinges.	Painting.

Fanlights and Transoms.

Jambs.	Fastenings.
Casings.	Nails and screws.
Moldings.	Labor.
Sash and glass.	Cartage.
Pivots.	Painting.
Hinges.	

Bay-Window.

Sills.	Screens.
Joists.	Brackets.
Studding.	Roof covering—slate,
Plates.	shingles, tin, &c.
Rafters.	Flashings.
Rough sheeting.	Gutters.
Pine covering.	Flooring.
Cornice.	Moldings.
Windows.	Angle beads.
Outside blinds.	Base.
Trimmings for outside	Grounds.
blinds.	Labor.
Inside blinds.	Cartage.
Trimmings for inside	Painting.
blinds.	

Floors.

Bridging.	Hardwood flooring.
Rough flooring.	Nails.
Pine flooring.	Cartage.
Hard pine flooring.	Oiling.
Spruce flooring.	

Principal Stairs.

Timber.	Wall rosettes.
Lumber.	Joint bolts.
Steps.	Newel bolts.
Risers.	Rail stays.
Moldings.	Angle posts.
Brackets.	Nails and screws.
Newels.	Labor.
Balusters.	Cartage.
Handrail.	Painting.

Attic Stairs.

Timber.	Nails and screws.
Lumber.	Labor.
Rail.	Cartage.
Posts.	Painting.
Balusters.	

Back Stairs.

Timber.	Wall rosettes.
Lumber.	Joint bolts.
Steps.	Newel bolts.
Risers.	Rail stays.
Moldings.	Angle posts.
Brackets.	Nails and screws.
Newels.	Labor.
Balusters.	Cartage.
Hand-rails.	Painting.

Cellar Stairs.

Timber.	Nails.
Lumber.	Labor.
Rail.	Cartage.
Posts.	Painting.

Mantels.

Mirror.	Tile facings.
Mirror frame.	Hearths.
Pine lumber.	Marble.
Hardwood lumber.	Labor.
Moldings.	Cartage.
Nails and screws.	Painting.

Closets.

Shelving.	Drawer rolls.
Standards.	Wardrobe strips.
Cleats.	Wardrobe hooks.
Drawers.	Nails and screws.
Formings.	Labor.
Drawer pulls.	Cartage.
Drawer locks.	Painting.

Coal-bins and Partitions in Cellar.

Timber.	Nails and screws.
Lumber.	Labor.
Flooring.	Cartage.

Front Doors and Vestibule Doors.

Jambs.	Locks.
Face and back casings.	Bolts.
Grounds.	Nails and screws.
Moldings.	Base knobs.
Corner blocks.	Thresholds.
Plinths.	Screens.
Doors.	Labor.
Hinges.	Cartage.
Knobs and latches.	Painting.

Sliding Doors.

Framework.	Sheaves and hangers.
Jambs.	Track.
Face and back casings.	Locks.
Moldings.	Knobs and latches.
Grounds.	Bolts.
Corner blocks.	Nails and screws.
Stops.	Labor.
Plinths.	Cartage.
Doors.	Painting.
_____	_____
_____	_____
_____	_____
_____	_____

Common Doors.

Jambs. -	Locks.
Face and back casings.	Bolts.
Moldings.	Nails and screws.
Grounds.	Base knobs.
Corner blocks.	Thresholds.
Plinths.	Screws.
Doors.	Labor.
Hinges.	Cartage.
Knobs and latches.	Painting.
_____	_____
_____	_____
_____	_____

Storeroom.

Shelving.	Drawer locks.
Standards.	Grounds.
Cleats.	Cedar lining to cup-
Cupboards.	board.
Doors to cupboards.	Wardrobe strips.
Door trimmings.	Wardrobe hooks.
Drawers.	Nails and screws.
Formings.	Labor.
Drawer pulls.	Cartage.
Drawer rolls.	Painting.

Pantry.

Shelving.	Grounds.
Cleats.	Platform shelf.
Standards.	Platform riser.
Cupboards.	Lid over flour barrel.
Doors to cupboards.	Hinges.
Door trimmings.	Pastry board.
Drawers.	Hooks.
Formings.	Nails and screws.
Drawer pulls.	Labor.
Drawer rolls.	Cartage.
Drawer locks.	Painting.

Butler's Pantry.

Shelving.	Grounds.
Cleats.	Platform shelf.
Standards.	Platform riser.
Cupboards.	Butler's sink.
Doors to cupboards.	Drip board.
Door trimmings.	Splash board.
Drawers.	Pipe covering.
Formings.	Nails and screws.
Drawer pulls.	Labor.
Drawer rolls.	Cartage.
Drawer locks.	Painting.

Cold-Air Duct.

Lumber.	Screen.
Timber.	Labor.
Damper slides.	Cartage.
Nails and screws.	

Tank.

Timber frame.	Pipe covering.
Pine plank.	Labor.
Rods and bolts.	Cartage.
Nails and screws.	Painting.

Kitchen Sink, &c.

Formings.	Nails and screws.
Sink.	Pipe covering.
Doors.	Kitchen table.
Door trimmings.	Towel roll.
Drip board.	Labor.
Splash board.	Cartage.
Grounds.	Painting.

Wash Trays

Frame.	Pipe covering.
Pine plank.	Porcelain or cement
Rods and bolts.	trays.
Nails and screws.	Labor.
Covers.	Cartage.
Hinges.	Painting.

Wainscoting and Base.

Lumber.	Nails and screws.
Capping.	Labor.
Moldings.	Cartage.
Paneling.	Painting.
Grounds.	

Bathroom.

Top to bathtub.	Nails and screws.
Risers.	Pipe covering.
Grounds.	Labor.
Wainscoting.	Cartage.
Moldings.	Painting.
_____	_____
_____	_____
_____	_____

Water-Closet.

Seat.	Hinges.
Flaps.	Nails and screws.
Risers.	Pipe covering.
Wainscoting.	Labor.
Moldings.	Cartage.
Grounds.	Painting.
_____	_____
_____	_____
_____	_____

Washstand.

Frame.	Nails and screws.
Sheeting.	Pipe covering.
Door.	Labor.
Door trimmings.	Cartage.
Grounds.	Painting.
_____	_____
_____	_____
_____	_____

Dressers.

Pine lumber.	Formings.
Hardwood lumber.	Drawer pulls.
Shelving.	Drawer rolls.
Paneling.	Drawer locks.
Doors (solid.)	Nails and screws.
Doors (glass.)	Labor.
Door trimmings.	Cartage.
Drawers.	Painting.

Slop Sink.

Sheeting.	Pipe covering.
Door.	Labor.
Door trimmings.	Cartage.
Grounds.	Painting.
Nails and screws.	

Bookcases.

Pine lumber.	Doors.
Hardwood lumber.	Glass in doors.
Drawers.	Shelving.
Formings.	Shelf ratchets.
Drawer pulls.	Moldings.
Drawer locks.	Carvings.

Bookcases (Continued.)

Nails and screws.	Painting.
Labor.	Oiling and polishing.
Cartage.	

Outbuildings.

Sills.	Hinges.
Posts.	Sheeting lumber.
Studs.	Clapboards and siding.
Plates.	Doors.
Rafters.	Door casings.
Girts.	Door trimmings.
Roof boards.	Windows.
Roof covering—shingles, tin, slate.	Window trimmings.
Ridge boards.	Blinds.
Joists.	Blind trimmings.
Ceiling.	Lattice work.
Ventilator.	Lattice posts.
Cornice.	Lattice rails.
Floors.	Nails and screws.
Seat in privy.	Labor.
Risers.	Cartage.
Flaps.	Painting.

Cupola.

Timber.	Ceiling.
Sheeting, sides and roof.	Casings.
Paper.	Windows.
Roof covering—shingles,	Sash and glass.
tin, slate.	Window trimmings.
Flashings.	Blinds.
Cornice.	Blind trimmings.
Cornice brackets.	Nails and screws.
Moldings.	Labor.
Foot brackets.	Cartage.
Finial.	Painting.
Brackets to finial.	

Fences.

Posts.	Lumber in base.
Casings.	Pickets.
Rails.	Nails and screws.
Gates.	Labor, including dig-
Gate trimmings.	ging.
Double gates.	Cartage.
Trimmings for same.	Painting.

Miscellaneous.

Bells.	Temporary doors and
Speaking tubes.	windows.
Coal shute.	Centers for mason.
Angle beads.	Cleaning premises.
Grounds.	Cartage.
Outside steps.	Clothes posts.
Cutting for craftsmen.	Insurance.
Finishing labor.	Heating building.
Ornamental iron work.	

CARPENTRY.

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PAINTING.

Body of house.

Trimmings.

Blinds.

Roofs.

Porches.

Inside work.

Floors.

Ceiling.

Walls.

Sash.

Shelving.

Fences.

Outbuildings.

Mantels.

Oiling.

Polishing,

Varnishing.

TINNING, SLATING AND GALVANIZED
IRON WORK.

Tin Roofing.

Flat-seam roofing.	Solder.
Standing-seam roofing.	Painting.
Paper or felt.	Labor.
Gutter linings.	Cartage.
_____	_____
_____	_____
_____	_____

Gutters and Spouting.

Hanging gutter.	Conductor hooks or
Tin conductor pipe.	fastenings.
Galvanized iron conduc-	Cast shoes or boots.
tor pipe.	Rain-water cut-off.
Corrugated conductor	Painting.
pipe.	Labor.
Spiral conductor pipe.	Cartage.
Conductor heads.	_____
_____	_____
_____	_____
_____	_____

Furnace.

Furnace.	Register boxes.
Hot-air pipe.	Iron lath.
Dampers in same.	Double thimbles.
Smoke-pipe.	Collars.
Check damper.	Labor.
Registers.	Cartage.
_____	_____
_____	_____
_____	_____

Kitchen Range.

Stove or range.	Collar.
Smoke-pipe.	Labor.
Thimble.	Cartage.
Damper.	_____
_____	_____
_____	_____

Miscellaneous Tinning.

Flashings, tower, chimney, &c.	Scuttle covering and flashing.
Valley linings.	Ventilators.
Hip and ridge coverings.	Chimney tops.
Iron roofing.	_____
_____	_____
_____	_____
_____	_____

Galvanized Iron Cornice.

Moldings.	Ornaments.
Panels.	Iron brackets or look-
Brackets.	outs.
Modillions.	Labor.
Dentils.	Cartage.

Slate Roofing.

Black slate.	Materials for pointing.
Green slate.	Flashing pieces.
Purple slate.	Gutters for chimneys.
Red slate.	Ridge and hip molding.
Paper or felt.	Labor.
Common nails.	Cartage.
Galvanized nails.	

PLUMBING AND GAS FITTING.

Preliminary Work, &c.

Excavation for service pipe.	Street washer.
Tapping water main.	Fittings.
Main service pipe.	Labor.
Stop and waste cocks.	Cartage.
_____	_____
_____	_____
_____	_____

Laundry Tubs.

Tubs.	Trap.
Service pipes.	Ventilation pipe.
Air chamber.	Drain.
Cocks.	Solder, charcoal, &c.
Metal tacks.	Labor.
Plugs and chains.	Cartage.
Waste pipe.	_____
_____	_____
_____	_____
_____	_____

Pump, &c.

Force pump.	Metal tacks.
Air chamber.	Solder, charcoal, &c.
Suction pipe.	Labor.
Riser pipe.	Cartage.
_____	_____
_____	_____

Tank.

Lining tank.	Stop cock.
Lead tray under tank.	Overflow pipe.
Tacks.	Tell-tale pipe.
Solder, charcoal, &c.	Labor.
Check valve.	Cartage.
_____	_____
_____	_____

Kitchen Sink.

Sink.	Lead safes.
Pump.	Trap.
Suction pipe.	Ventilation pipe.
Metal tacks.	Solder, charcoal, &c.
Service pipe.	Drain.
Air chamber.	Labor.
Waste pipe.	Cartage.
_____	_____
_____	_____
_____	_____

Range Boiler.

Boiler.	Stop cocks.
Boiler stand.	Sediment cock.
Piping.	Waste pipe.
Circulating pipes.	Labor.
Metal tacks.	Cartage.

Water-Closet.

Closet.	Service cistern.
Service pipe.	Lead safes.
Trap.	Solder and charcoal.
Ventilation pipe.	Labor.
Soil pipe.	Cartage.
Drain.	

Slop Sink.

Sink.	Ventilation pipe.
Service pipes.	Drain.
Metal tacks.	Lead safes.
Cocks.	Solder, charcoal, &c.
Trap.	Labor.
Waste pipe.	Cartage.

Wash Bowls.

Basins.	Waste pipe.
Slabs.	Ventilation pipe.
Service pipes.	Overflow.
Metal tacks.	Lead safes.
Cocks.	Solder and charcoal.
Plugs and chains.	Labor.
Traps.	Cartage.

Bathtubs.

Tubs.	Plugs, chains, &c.
Service pipes.	Ventilation pipe.
Cocks.	Overflow.
Metal tacks.	Solder, charcoal, &c.
Waste pipe.	Labor.
Trap.	Cartage.
Lead safes.	

Shower-Bath.

Shower.	Metal tacks.
Service pipe.	Solder, charcoal, &c.
Cocks.	Labor.

Soil Pipe, Drains, &c.

Main soil pipe and connections.

Ventilator cap.

Calking material.

Drain outside of walls.

Excavation.

Cesspool.

Gas Fitting.

Excavating for pipes.

Main supply pipe.

Fittings.

Branch pipes.

Drop-light fixtures.

Side-light fixtures.

Labor.

Cartage.

A SELECTION OF
TABLES, RULES AND FORMULÆ
USEFUL IN
PREPARING BUILDING ESTIMATES.

EPITOME OF MENSURATION.

Explanation of Signs and Terms.

- = sign of equality ; read "equals."
- + sign of addition ; read "plus."
- sign of subtraction ; read "minus."
- × sign of multiplication ; read "multiplied by."
- ÷ sign of division ; read "divided by."

$\sqrt{\quad}$ sign of square root, and signifies that such a number is to be found as multiplied by itself will produce the given number. Thus, $\sqrt{25} = 5$. Proof, $5 \times 5 = 25$.

5^2 The small figure (²) above and at the right indicates that the number to which it is affixed is to be squared or multiplied by itself. Thus $5^2 = 25$. A^3 in the same position indicates that the number is to be cubed—that is, multiplied by itself twice, or taken as a factor three times. Thus, $5^3 = 125$. "Diameter²" in the following formulæ indicates that the diameter, whatever it may be, is to be squared or multiplied by itself :

Area of a triangle = base \times $\frac{1}{2}$ altitude.

Area of a parallelogram = base \times altitude.

Area of a trapezoid = altitude \times $\frac{1}{2}$ the sum of parallel sides.

Area of a trapezium : Divide into two triangles and find area of the triangles.

Circumference of circle = diameter \times 3.1416 or $3\frac{1}{7}$.
The latter is a convenient approximation.

Diameter of circle = circumference \times .3183.

Area of circle = diameter² \times 7854.

Area of sector of circle = length of arc \times $\frac{1}{2}$ the radius.

Area of segment of circle = area of sector of equal

radius — area of triangle when the segment is less, and
 + area of triangle when the segment is greater than the
 semicircle.

Area of circular ring = diameters of the two circles \times
 difference of diameter and that product by .7854.

Side of square that shall equal area of circle = diameter
 \times .8862, or circumference \times .2821.

Diameter of circle that shall contain area of a given
 square = side of square \times 1.1284.

Area of an ellipse = product of the two diameters
 \times .7854.

Area of parabola = base $\times \frac{2}{3}$ altitude.

Area of regular polygon = sum of its sides \times the per-
 pendicular from its center to one of its sides $\div 2$.

Surface of cylinder or prism = area of both ends +
 length \times circumference.

Contents of cylinder or prism = area of end \times length.

Surface of sphere = diameter \times circumference.

Contents of sphere = diameter³ \times .5236.

Surface of pyramid or cone = circumference of base \times
 $\frac{1}{2}$ of the slant height + area of the base.

Contents of pyramid or cone = area of base $\times \frac{1}{3}$
 altitude.

Surface of frustum of cone or pyramid = sum of circum-
 ference at both ends $\times \frac{1}{2}$ slant height + area of both ends.

Contents of frustum of cone or pyramid: Multiply
 areas of two ends together and extract square root. Add
 to this root the two areas and $\times \frac{1}{3}$ altitude.

Contents of a wedge = area of base $\times \frac{1}{2}$ altitude.

MULTIPLIERS FOR FACILITATING CALCULATIONS.

Cubic inches	×	.260	=	lbs. cast iron.
Cubic inches	×	.281	=	lbs. wrought iron.
Cubic inches	×	.283	=	lbs. steel.
Cubic inches	×	.321	=	lbs. copper.
Cubic inches	×	.307	=	lbs. brass.
Cubic inches	×	.41	=	lbs. lead.
Cubic inches	×	.09	=	lbs. common stone.
Cubic inches	×	.078	=	lbs. clay.
Cubic inches	×	.055	=	lbs. loose earth.
Cubic inches	×	.033	=	lbs. dry oak.
Cubic inches	×	.017	=	lbs. dry pine.
Cubic inches	×	.031	=	lbs. coal.
Cubic inches	×	.016	=	lbs. charcoal.
Cubic inches	×	.036	=	lbs. fresh water.
Cubic inches	×	.035	=	lbs. ice.
Cubic inches	×	.00433	=	lbs. U. S. gallons.
Cubic inches	×	.000465	=	lbs. U. S. bushels.
Cubic inches	×	.00058	=	lbs. cubic feet.
Cubic feet	×	450.	=	lbs. cast iron.
Cubic feet	×	487.	=	lbs. wrought iron.
Cubic feet	×	490.	=	lbs. steel.
Cubic feet	×	556.	=	lbs. copper.
Cubic feet	×	532.	=	lbs. brass.
Cubic feet	×	710.	=	lbs. lead.
Cubic feet	×	156.	=	lbs. common stone.
Cubic feet	×	135.	=	lbs. clay.
Cubic feet	×	95.	=	lbs. loose earth.

Cubic feet	×	58.	= lbs. dry oak.
Cubic feet	×	30.	= lbs. dry pine.
Cubic feet	×	54.	= lbs. coal.
Cubic feet	×	27.5	= lbs. charcoal.
Cubic feet	×	62.5	= lbs. fresh water.
Cubic feet	×	60.5	= lbs. ice.
Cubic feet	×	7.478	= lbs. U. S. gallons.
Cubic feet	×	.80352	= lbs. U. S. bushels.

Lineal feet	×	.00019	= miles.
Lineal yards	×	.000568	= miles.
Square inches	×	.007	= square feet.
Square feet	×	.111	= square yards.
Cubic feet	×	.0371	= cubic yards.
Cubic inches	×	.000579	= cubic feet.
Pounds	×	.000448	= tons.
Bushels	×	1.244	= cubic feet.
Gallons	×	.1336	= cubic feet.
Gallons (U. S.)	×	231.	= cubic inches.
Bushels.	×	2150.42	= cubic inches.

Thickness of wrought-iron plates in inches $\times 40$ = pounds per square foot.

The same in eighths of inches $\times 5$ = pounds per square foot.

The sectional area of wrought-iron plates in inches $\times 3.34$ = pounds per lineal foot.

The same in eighths of inches $\times .052$ = pounds per lineal foot.

Diameter of round iron in inches squared $\times 2.64$ = pounds per lineal foot.

MATERIAL FOR PLASTERING.

The following estimate of materials is from Cameron's "Plasterer's Manual:"

Bill of Material for One Hundred Yards of Plastering—Three Coats.—Eight bushels lime, one bushel hair, one load sand, one-quarter barrel plaster. This, of course, varies somewhat with the qualities of material. About two bushels of lime are required for the finishing, the other six for the coarse mortar

The average weight of one bushel of mortar is $131\frac{1532}{1728}$ pounds. The average weight of one bushel of sand is 120 pounds. The standard weight of one bushel of lime is 80 pounds. The standard weight of one bushel of hair is 8 pounds.

When lath are $1\frac{1}{2}$ inches wide and are nailed $\frac{3}{8}$ inch apart, 1440 are required for 100 yards. With studding or joists 16 inches apart, 10 pounds of 3d nails are required.

SAFE LOADS IN STRUCTURES.

The best engineering authorities as collated by Vogdes recommend the following factors of safety, the safe loads to include the weight of the structure itself :

For cast-iron columns, least factor of safety	4
For wrought-iron constructions, least factor of safety	4
For cast-iron beams or girders, with moving loads, least factor of safety	8
For same with constant, quiescent loads	6
For all timber constructions, least factor of safety	10
For stone and brickwork, least factor of safety . .	8
For bridgework of any material, least factor of safety	10

Manufacturing establishments should be calculated with the same factor of safety as for moving loads.

Buildings designed for dwellings and ordinary office purposes may be estimated at 150 pounds load per superficial foot of floor space, including joists, flooring, furniture and occupants.

Churches, public halls, hospitals and ordinary stores are estimated at 175 pounds per superficial

foot of floor space, including floors, &c. Heavy stores and factories should be estimated at not less than 200 pounds per superficial foot.

Roofs, in addition to weight of frame, slate or other covering, ceiling joist and plastering (if any are suspended from it), to provide for snow and sleet, should be estimated at not less than 20 pounds per superficial foot, and for wind pressure at not less than 20 pounds additional. The weight of columns, beams, &c., must always be calculated as forming parts of the actual load.

SHEET IRON.

Table showing the weight per square foot of Galvanized Sheet Iron, and also the weight of Corrugated Iron Roofing.

GAUGE NUMBER.	GALVANIZED SHEET IRON.	CORRUGATED IRON.	
	Weight per Square Foot.	Weight per Square Foot.	Weight per Square Foot. of Roof, Laps Included.
	Oz	Lbs.	Lbs.
14	60	4.10	4.92
16	48	3.29	3.95
17	43	2.98	3.57
18	38	2.58	3.09
19	33	2.26	2.71
20	28	1.94	2.33
21	24	1.81	2.17
22	21	1.62	1.95
23	19	1.49	1.79
24	17	1.36	1.62
25	16	1.27	1.52
26	15	1.18	1.41
27	14	1.09	1.30
28	13	.997	1.20
29	12	.952	1.14

CALCULATING THE STRENGTH OF COLUMNS.

The following formulæ, derived from "Gordon's Rule," are given in Vodges' "Architects' and Builders' Companion," for determining the strength of columns :




SOLIDS.		
MATERIAL.	SQUARE.	CYLINDER.
Cast Iron, W =	$\frac{A \times 80,000}{1 + \left(\frac{L^2}{206.7 \times S^2} \right)}$	$\frac{A \times 80,000}{1 + \left(\frac{L^2}{200 \times D^2} \right)}$
Wrought Iron, W =	$\frac{A \times 36,000}{1 + \left(\frac{L^2}{3,000 \times S^2} \right)}$	$\frac{A \times 36,000}{1 + \left(\frac{L^2}{2,250 \times D^2} \right)}$
Pine (white } or yellow) }	W = $\frac{A \times 5000}{1 + \left(\frac{L^2}{S^2} \times .004 \right)}$	$\frac{A \times 5,000}{1 + \left(\frac{L^2}{D^2} \times .003 \right)}$
Oak (white } and black) }	W = $\frac{A \times 6000}{1 + \left(\frac{L^2}{S^2} \times .004 \right)}$	$\frac{A \times 6000}{1 + \left(\frac{L^2}{D^2} \times .003 \right)}$
HOLLOWS.		
MATERIAL.	SQUARE.	CYLINDER.
Cast Iron, W =	$\frac{A \times 80,000}{1 + \left(\frac{L^2}{534.3 \times S^2} \right)}$	$\frac{A \times 80,000}{1 + \left(\frac{L^2}{d^2} \div 400 \right)}$
Wrought Iron, W =	$\frac{A \times 36,000}{1 + \left(\frac{L^2}{6000 \times S^2} \right)}$	$\frac{A \times 36,000}{1 + \left(\frac{L^2}{d^2} \div 3000 \right)}$

In the above, A = sectional area. L = length or height in inches. S = side of square column in inches. D = outer diameter in inches. d = interior diameter in inches. W = strength or load in lbs.

Calculating the Transverse Strength of
Beams and Girders Supported at Both
Ends and Loaded in the Center.

The following rule is given by Vodges :

The breadth of the beam in inches multiplied by the square of the depth in inches, divided by the clear span in feet, and the result multiplied by the following constants, will give the breaking weight in net tons (2000 pounds):

CONSTANT FOR			
Cast Iron.....	1.1	.78	.647
Wrought Iron.....	1.25	.885	.737
Steel.....	2.5	1.75	1.47
Brass . . . . .	.45	.32	.265
Copper . . . . .	.425	.3	.25
Ash.....	.325	.23	.191
Beech.....	.25	.177	.147
White Pine.....	.225	.159	.132
Yellow Pine.....	.275	.195	.162
Oak, Live and White...	.3	.213	.176
Locust.....	.3	.213	.176
Poplar.....	.275	.195	.162
Sycamore.....	.25	.177	.147
Spruce.....	.225	.159	.132
Walnut.....	.225	.159	.132
Maple.....	.275	.195	.16
Hemlock.....	.2	.142	.118
Chestnut.....	.225	.159	.132
Hickory.....	.35	.248	.206

WINDOW GLASS.

The following table shows the number of lights per box of 50 feet :

Inches.	No.	Inches.	No.	Inches.	No.	Inches.	No.
6×8	150	12×18	33	16×44	10	26×32	9
7×9	115	12×20	30	18×20	20	26×34	8
8×10	90	12×22	27	18×22	18	26×36	8
8×11	82	12×24	25	18×24	17	26×40	7
8×12	75	12×26	23	18×26	15	26×42	7
8×13	70	12×28	21	18×28	14	26×44	6
8×14	64	12×30	20	18×30	13	26×48	6
8×15	60	12×32	18	18×32	13	26×50	6
8×16	55	12×34	17	18×34	12	26×54	5
9×11	72	13×14	40	18×36	11	26×58	5
9×12	67	13×16	35	18×38	11	28×30	9
9×13	62	13×18	31	18×40	10	28×32	8
9×14	57	13×20	28	18×44	9	28×34	8
9×15	53	13×22	25	20×22	16	28×36	7
9×16	50	13×24	23	20×24	15	28×38	7
9×17	47	13×26	21	20×26	14	28×40	6
9×18	44	13×28	19	20×28	13	28×44	6
9×20	40	13×30	18	20×30	12	28×46	6
10×12	60	14×16	32	20×32	11	28×50	5
10×13	55	14×18	29	20×34	11	28×52	5
10×14	52	14×20	26	20×36	10	28×56	4
10×15	48	14×22	23	20×38	9	30×36	7
10×16	45	14×24	22	20×40	9	30×40	6
10×17	42	14×26	20	20×44	8	30×42	6
10×18	40	14×28	18	20×46	8	31×44	5
10×20	36	14×30	17	20×48	8	30×46	5
10×22	33	14×32	16	20×50	7	30×48	5
10×24	30	14×34	15	20×60	6	30×50	5
10×26	28	14×36	14	22×24	14	30×54	4
10×28	26	14×40	13	22×26	13	30×56	4
10×30	24	14×44	11	22×28	12	30×60	4
10×32	22	15×18	27	22×30	11	32×42	5
10×34	21	15×20	24	22×32	10	32×44	5
11×13	50	15×22	22	22×34	10	32×46	5
11×14	47	15×24	20	22×36	9	32×48	5
11×15	44	15×26	18	22×38	9	32×50	4
11×16	41	15×28	17	22×40	8	32×54	4
11×17	39	15×30	16	22×44	8	32×56	4
11×18	36	15×32	15	22×46	7	32×60	4
11×20	33	16×18	25	22×50	7	34×40	5
11×22	30	16×20	23	24×28	11	34×44	5
11×24	27	16×22	20	24×30	10	34×46	5
11×26	25	16×24	19	24×32	9	34×50	4
11×28	23	16×26	17	24×36	8	34×52	4
11×30	21	16×28	16	24×40	8	34×56	4
11×32	20	16×30	15	24×44	7	36×44	5
11×34	19	16×32	14	24×46	7	36×50	4
12×14	43	16×34	13	24×48	6	36×56	4
12×15	40	16×36	12	24×50	6	36×60	3
12×16	38	16×38	12	24×54	5	36×64	3
12×17	35	16×40	11	24×56	5	40×60	3

SASH WEIGHTS.

The following table gives the weight of sash weights required for windows of various sizes, four weights being calculated for each window :

Size of Glass.	Thickness of Sash.	Number of Lights.	Weight. Lbs.
10 × 14	$1\frac{3}{8}$	12	6
10 × 16	$1\frac{3}{8}$	8	6
12 × 14	$1\frac{3}{8}$	8	6
10 × 15	$1\frac{3}{8}$	12	7
10 × 16	$1\frac{3}{8}$	12	7
10 × 18	$1\frac{3}{8}$	8	7
10 × 20	$1\frac{3}{8}$	8	7
12 × 15	$1\frac{3}{8}$	8	7
12 × 16	$1\frac{3}{8}$	8	7
14 × 16	$1\frac{3}{8}$	8	7
10 × 18	$1\frac{3}{8}$	12	8
12 × 18	$1\frac{3}{8}$	8	8
12 × 20	$1\frac{3}{8}$	8	8
12 × 22	$1\frac{3}{8}$	8	8
14 × 18	$1\frac{3}{8}$	8	8
14 × 20	$1\frac{3}{8}$	8	8
12 × 36	$1\frac{3}{8}$	4	8
10 × 20	$1\frac{3}{8}$	12	9
12 × 24	$1\frac{3}{8}$	8	9
15 × 22	$1\frac{3}{8}$	8	9
12 × 40	$1\frac{3}{8}$	4	9
12 × 44	$1\frac{3}{8}$	4	9
14 × 36	$1\frac{3}{8}$	4	9
10 × 22	$1\frac{3}{8}$	12	10
10 × 24	$1\frac{3}{8}$	12	10
12 × 18	$1\frac{3}{8}$	12	10
12 × 20	$1\frac{3}{8}$	12	10
14 × 22	$1\frac{3}{8}$	8	10
14 × 24	$1\frac{3}{8}$	8	10
14 × 40	$1\frac{3}{8}$	4	10
14 × 44	$1\frac{3}{8}$	4	10
12 × 22	$1\frac{3}{8}$	12	11
15 × 48	$1\frac{3}{4}$	4	12

WEIGHTS OF LEAD AND TIN-LINED LEAD PIPE.

Caliber.	Letter.	Weight per Foot and Rod.	Thickness in 1-100th in.	Caliber.	Letter.	Weight per Foot and Rod.	Thickness in 1-100th in.
$\frac{3}{8}$ in.	D	7 lbs. pr. rod.	6	$\frac{1}{2}$ in.	E	24 $\frac{3}{4}$ lbs. pr. rod.	10
"	C	10 oz. per ft.	8	"	D	22 " pr. ft.	11
"	B	1 lb. "	12	"	C	21 " "	14
"	A	1 $\frac{1}{2}$ " "	16	"	B	3 $\frac{1}{2}$ " "	17
"	AA	1 $\frac{1}{2}$ " "	19	"	A	4 $\frac{1}{2}$ " "	21
"	AAA	2 $\frac{1}{2}$ " "	34	"	AA	4 $\frac{1}{2}$ " "	24
$\frac{1}{2}$ in.	E	9 " pr. rod.	7	"	AAA	6 " "	30
"	D	8 $\frac{3}{4}$ " pr. ft.	9	$\frac{1}{4}$ in.	E	2 " "	10
"	C	1 " "	11	"	D	2 $\frac{1}{2}$ " "	12
"	B	1 $\frac{1}{4}$ " "	13	"	C	3 " "	14
"	A	1 $\frac{1}{2}$ " "	16	"	B	3 $\frac{3}{4}$ " "	16
"	AA	2 " "	19	"	A	4 $\frac{3}{4}$ " "	19
"	AAA	3 " "	25	"	AA	6 " "	25
$\frac{5}{8}$ in.	E	12 " pr. rod.	8	$\frac{1}{2}$ in.	E	3 " "	12
"	D	11 " pr. ft.	9	"	D	3 $\frac{1}{2}$ " "	14
"	C	1 $\frac{1}{2}$ " "	13	"	C	4 $\frac{1}{2}$ " "	17
"	B	2 " "	16	"	B	5 " "	19
"	A	2 $\frac{1}{2}$ " "	20	"	A	6 $\frac{1}{2}$ " "	23
"	AA	2 $\frac{3}{4}$ " "	22	"	AA	8 " "	27
"	AAA	3 $\frac{1}{2}$ " "	25	$\frac{3}{4}$ in.	C	4 " "	13
$\frac{3}{4}$ in.	E	16 " pr. rod.	8	"	B	5 " "	17
"	D	15 $\frac{1}{4}$ " pr. ft.	10	"	A	6 $\frac{1}{2}$ " "	21
"	C	1 $\frac{3}{4}$ " "	12	"	AA	8 $\frac{1}{2}$ " "	27
"	B	2 " "	16	2 in.	C	4 $\frac{3}{4}$ " "	15
"	A	3 " "	20	"	B	6 " "	18
"	AA	3 $\frac{1}{2}$ " "	23	"	A	7 " "	22
"	AAA	4 $\frac{1}{4}$ " "	30	"	AA	9 " "	27

LEAD PIPE IN LENGTHS OF 10 FEET.

Inches.	$\frac{3}{8}$ Inch Thick.	$\frac{5}{16}$ Inch Thick.	$\frac{1}{4}$ Inch Thick	$\frac{3}{16}$ Inch Thick.
	lb. oz.	lb. oz.	lb. oz.	lb. oz.
$2\frac{1}{2}$	17 0	14 0	11 0	8 0
3	20 0	16 0	12 0	9 0
$3\frac{1}{2}$	22 0	18 8	15 0	9 8
4	25 0	21 0	16 0	12 8
$4\frac{1}{2}$	.. ..	.. ..	18 0	14 0
5	31 0	.. ..	20 0	.. ..

LEAD WASTE-PIPE.

$1\frac{1}{2}$ in., 2 lbs. per ft.	4 in., 5, 6 and 8 lbs. per ft.
2 " 3 lbs. "	$4\frac{1}{2}$ " 6 and 8 lbs.
3 " $3\frac{1}{2}$ and 5 lbs per ft.	5 " 8, 10 and 12 lbs.

SHEET LEAD.

Weight per square foot, $2\frac{1}{2}$, 3, $3\frac{1}{2}$, 4, $4\frac{1}{2}$, 5, 6, 8, 9, 10 lbs. and upward.

BLOCK TIN PIPE.

$\frac{3}{8}$ in., $4\frac{1}{2}$, $6\frac{1}{2}$ and 8 oz. per ft.	1 in., 15 and 18 oz. per ft.
$\frac{1}{2}$ in., 6, $7\frac{1}{2}$ and 10 oz. per ft.	$1\frac{1}{4}$ in., $1\frac{1}{4}$ and $1\frac{1}{2}$ lbs. per ft.
$\frac{5}{8}$ in., 8 and 10 oz. per ft.	$1\frac{1}{2}$ in., 2 and $2\frac{1}{2}$ lbs. per ft.
$\frac{3}{4}$ in., 10 and 12 oz. ft.	2 in., $2\frac{1}{2}$ and 3 lbs. per ft.

SLATING.

The following table, showing the number of slate required to lay one square with variations of lap, is furnished by Messrs. Auld & Conger, Cleveland, Ohio. Three-inch is the standard lap at which slate is bought and sold. Where a less lap is used the same number of slate will cover a larger area, and where a greater lap is used the same number will cover a smaller area, than is usually estimated, all as shown in the table :

SIZES OF SLATE AND NUMBER OF PIECES REQUIRED PER SQUARE,
WITH DIFFERENT LAPS.

Size of Slate.	Lap 2 In.	Lap 2½ In.	Lap 3 In.	Lap 3½ In.	Lap 4 In.
24 x { 16 15 14 13 12	82 87 93 101 109	84 89 95 103 111	85 91 98 105 115	88 93 100 108 117	90 96 103 111 120
22 x { 14 13 12 11	103 111 120 131	105 113 123 134	108 116 126 138	111 120 130 141	114 123 133 145
20 x { 14 13 12 11 10	114 123 133 145 160	117 126 137 149 164	121 130 141 154 170	124 134 145 158 174	128 138 150 163 180
18 x { 12 11 10 9	150 163 180 200	155 169 186 206	160 174 192 213	165 180 198 220	171 187 205 228
16 x { 12 10 9 8	171 206 228 257	177 213 237 266	184 222 246 277	192 230 256 288	200 240 266 300
14 x { 10 9 8 7	240 266 300 343	250 278 313 358	262 291 327 374	274 304 343 392	288 320 360 411
12 x { 10 9 8 7 6	288 320 360 411 480	303 337 379 433 505	320 355 400 457 533	339 376 423 484 565	360 400 450 514 600

SLATING—VARIATION IN LAP.

The loss or gain from variations in the lap of slate may be computed by the following table, also furnished by Messrs. Auld & Conger :

LENGTH OF SLATE.	AMOUNT EXPOSED TO WEATHER WHEN LAID.				
	2 Inch Lap.	2½ Inch Lap.	3 Inch Lap.	3½ Inch Lap.	4 Inch Lap.
12 in.	5 in.	4¾ in.	4½ in.	4¼ in.	4 in.
14 in.	6 in.	5¾ in.	5½ in.	5¼ in.	5 in.
16 in.	7 in.	6¾ in.	6½ in.	6¼ in.	6 in.
18 in.	8 in.	7¾ in.	7½ in.	7¼ in.	7 in.
20 in.	9 in.	8¾ in.	8½ in.	8¼ in.	8 in.
22 in.	10 in.	9¾ in.	9½ in.	9¼ in.	9 in.
24 in.	11 in.	10¾ in.	10½ in.	10¼ in.	10 in.

It is only the length of the slate that is affected by a variation of the lap. One inch variation in lap affects the different lengths of slate as follows :

On 12-inch Slate	$\frac{1}{6}$, or 11 per cent.
On 14-inch Slate.....	$\frac{1}{11}$, or 9 per cent.
On 16-inch Slate	$\frac{1}{13}$, or $7\frac{2}{3}$ per cent.
On 18-inch Slate....	$\frac{1}{15}$, or $6\frac{2}{3}$ per cent.
On 20-inch Slate	$\frac{1}{17}$, or $5\frac{7}{8}$ per cent.
On 22-inch Slate.....	$\frac{1}{19}$, or $5\frac{1}{4}$ per cent.
On 24-inch Slate.....	$\frac{1}{21}$, or $4\frac{3}{4}$ per cent.

SLATING.—QUANTITY OF NAILS.

The table on the next page, calculated by Messrs. Auld & Conger, Cleveland, Ohio, shows the size of slate, number to a square with 3-inch lap, and weight of nails in pounds and ounces to lay one square. The weight of the nails given is from actual count ; to this should be added from 10 to 25 per cent., according to the kind of job and size of slate. For plain roof, large slate, 10 per cent. is enough to add ; but the more the roof is cut up, and the smaller the slate, the more should be added. The reasons for this are that all half-slate or small pieces require two nails, same as a whole slate. Each piece of flashing requires one or more, and there is always waste from dropping nails by the men. The more nails to a square, the more will be lost.

SIZE OF SLATE.	No. TO SQUARE.	WEIGHT OF NAILS TO A SQUARE.								
		3-inch Lap.	4d.			3d.				
			Gal.	Tin.	Com.	Gal.	Tin.	Com.		
			lb. Oz.	lb. oz.	lb. oz.	lb. oz.	lb. oz.	lb. oz.		
24 x	{ 16	85..	I 3	I	I4	I	I3	I2		
	{ 15	92..	I 5	I I	I5	I I	I4	I3		
	{ 14	98..	I 6	I 2	I	I 2	I5	I4		
	{ 13	106..	I 8	I 4	I 2	I 4	I I	I		
	{ 12	115..	I 10	I 5	I 3	I 5	I 2	I I		
22 x	{ 14	108..	I 8	I 4	I 2	I 4	I I	I		
	{ 13	116..	I 10	I 6	I 4	I 6	I 3	I 2		
	{ 12	126..	I 12	I 7	I 5	I 7	I 4	I 3		
	{ 11	138..	I 15	I 9	I 7	I 9	I 5	I 4		
20 x	{ 14	121..	I 11	I 6	I 4	I 6	I 3	I 3		
	{ 12	141..	2	I 10	I 8	I 10	I 6	I 5		
	{ 11	154..	2 2	I 12	I 10	I 12	I 8	I 7		
	{ 10	170..	2 6	I 15	I 13	I 15	I 11	I 9		
18 x	{ 12	160..	2 4	I 13	I 11	I 13	I 9	I 8		
	{ 11	175..	2 7	2	I 13	2	I 11	I 10		
	{ 10	192..	2 11	2 3	2	2 3	I 14	I 13		
	{ 9	213..	3 8	2 7	2 4	2 7	2 I	2		
16 x	{ 12	184..	2 9	2 2	I 15	2 2	I 12	I 11		
	{ 10	222..	3 I	2 8	2 5	2 8	2 2	2 I		
	{ 9	246..	3 7	2 13	2 9	2 13	2 6	2 5		
	{ 8	277..	3 14	3 2	2 14	3 2	2 11	2 10		
14 x	{ 12	218..	3 I	2 8	2 5	2 8	2 2	2 I		
	{ 10	261..	3 10	3	2 12	3	2 8	2 7		
	{ 9	291..	4 I	3 5	3 I	3 5	2 13	2 12		
	{ 8	327..	4 9	3 12	3 7	3 12	3 2	3 I		
	{ 7	374..	5 3	4 4	3 15	4 4	3 10	3 9		
12 x	{ 10	320..	4 7	3 10	3 5	3 10	3 I	3		
	{ 9	355..	5	4	3 12	4	3 7	3 6		
	{ 8	400..	5 9	4 9	4 3	4 9	3 14	3 13		
	{ 7	457..	6 6	5 3	4 12	5 3	4 6	4 5		
	{ 6	533..	7 6	6 I	5 9	6 I	5 2	5 I		

SHIPPING WEIGHTS OF LUMBER.

The following table, showing the average weights, in pounds, obtained in the actual shipment from Chicago of 20,000,000 feet of pine lumber, during an entire season, is from the "Lumberman's Hand Book":

1, 1¼ and 1½ inch, surfaced one side.....	2102
The same, surfaced two sides.....	2068
2-inch, surfaced one side.....	2200
White-pine flooring, dressed and matched.....	1890
Hard-pine flooring.....	2366
Ship lap, 8-inch....	1711
Ship lap, 10-inch.....	1725
Ship lap, 12-inch.....	1855
White pine, ¾-inch ceiling.....	786
Hard pine, ¾-inch ceiling.....	950
Siding.....	865
Piece stuff, rough....	2560
Piece stuff, surfaced one side and one edge.....	2210
Thin clear, surfaced one side.	1380
¾ ceiling.....	1120
Rough boards.....	2524
Hard-pine fencing.....	2910
4-inch flooring, dressed and matched.....	1793
6-inch fencing.....	2433
Pine shingles.....	248
Cedar shingles ..	203
Dry lath.....	502

TIN ROOFING.

The thickness of tin plates is indicated by arbitrary characters, as IC (= wire gauge No. 29), IX (= wire gauge No. 27) and IXX (= wire gauge No. 26). The size of the plates is expressed in inches, as 14 x 20, 20 x 28, &c. The coating is either bright (tin) or terne (lead or roofing). The quality of the iron in the plate is commonly indicated by the terms charcoal (the best) and coke (inferior). Besides these indications of quality, in which there are almost endless variations, there are the brands or trade-marks of the makers or importers by which plates are bought and sold. "MF" is one of the best makers' brands of charcoal roofing tin at present in the market. Many reputable importers and dealers sell plates under guarantee, so that upon receiving a specification of requirements they send exactly what is wanted, irrespective of brand.

TABLE OF TIN AND TERNE PLATES.				
Gauge Mark.	Corresponding Wire Gauge.	Size of Sheets.	No. of Sheets per Box.	Weight, including Box.—Lbs.
IC.....	29	10 x 14	225	120
IX.....	27	10 x 14	225	150
IXX.....	26	10 x 14	225	170
IXXX.....	25	10 x 14	225	190
IC.....	29	14 x 20	112	120
IX.....	27	14 x 20	112	150
IXX.....	26	14 x 20	112	170
IXXX.....	25	14 x 20	112	190
IC.....	29	20 x 28	112	240
IX.....	27	20 x 28	112	300
IXX.....	26	20 x 28	112	340

Tin roofing is laid in two general ways, known respectively as flat-seam roofing and standing-seam roofing. In flat-seam roofing a sheet of 14 x 20 tin, (edged 13 x 19) will cover 247 square inches ; 59 sheets will cover a square of roof, while one box and five sheets will cover two squares. A sheet of 20 x 28 (edged 19 x 27) will cover 513 square inches ; 29 sheets will lay a square of roof, while one box and one sheet will cover four squares.

In standing-seam roofing, a sheet of 14 x 20 (after working 13 x $17\frac{3}{4}$) will cover $230\frac{3}{4}$ square inches ; 63 sheets will cover a square of roof, while one box and 13 sheets will cover two squares. A sheet of 20 x 28 (after working $17\frac{3}{4}$ x 27 inches) will cover $479\frac{1}{4}$ square inches ; 31 sheets will lay a square of roof, while one box and nine sheets will cover four squares.

QUANTITY OF NAILS.

The following estimate of the quantity of nails required in various work is taken from Hodgson's "Builders' Guide":

For 1000 shingles allow $3\frac{1}{2}$ to 5 lbs. 4d. nails; or 3 to $3\frac{1}{2}$ lbs. 3d. nails.	
For 1000 laths allow.....	about 6 lbs. 3d. fine nails.
For 1000 feet clapboards.....	about 18 lbs. 6d. box.
For 1000 feet boarding boards.....	20 lbs. 8d. com.
For 1000 feet boarding boards.....	25 lbs. 10d. com.
For 1000 feet top floors, square edge.....	38 lbs. 10d. floor.
For 1000 feet top floors, square edge.....	41 lbs. 12d. floor.
For 1000 ft. top fl'rs, matched blind nailed.....	35 lbs. 10d. floor.
For 1000 ft. top fl'rs, matched blind nailed.....	42 lbs. 12d. floor.
For 1000 feet partition studs or studding.....	1 lb. 10d. com.
For 1000 feet furring, 1 x 3.....	45 lbs. 10d. com.
For 1000 feet furring, 1 x 2.....	65 lbs. 10d. com.
For 1000 feet pine finish, about.....	30 lbs. 8d. finish.

WEIGHT OF MATERIALS.

THE WEIGHT IN POUNDS OF ONE CUBIC FOOT OF DIFFERENT KINDS OF BUILDING MATERIALS.—(HATFIELD.)

MATERIAL.	Weight per Cubic Foot.	MATERIAL.	Weight per Cubic Foot.
<i>Stones.</i>	lbs.	<i>Woods.</i>	lbs.
Bathstone.....	139	Ash.....	49
Béton coignet....	129	Beech.....	46
Bluestone.....	160	Birch.....	42
Granite, average..	165	Cedar.....	31
Limestone, average	169	Elm.....	46
Marble, average...	170	Hemlock.....	26
Sandstone, average	144	Oak, red.....	51
Slate.....	159	Oak, white.....	50
		Pine, white.....	28
<i>Metals.</i>		Pine, yellow.....	33
Cast-iron.....	450	Spruce.....	30
Wrought-iron.....	489		
Steel.....	489		

PHILADELPHIA

WELLS AND CISTERNS.

DIAMETER IN FEET.	FOR EACH FOOT IN DEPTH.				
	For this Column use the Diameter of the Digging.	For these Columns use the Diameter in Clear of the Lining.			
		Perches (25 Cubic Feet) of Stone Lin- ing 1 Foot Thick.	No. of Bricks in Lining 8¾ Inches or 1 Brick Thick.	Square Yards of Plaster- ing.	Capacity in Gallons.
3	.2618	.5027	170	1.047	52.88
3½	.3563	.5655	198	1.222	71.97
4	.4654	.6283	227	1.396	94.00
4½	.5890	.6912	255	1.571	118.96
5	.7272	.7540	283	1.745	146.87
5½	.8799	.8168	311	1.920	177.82
6	1.047	.8796	340	2.095	211.50
7	1.425	1.005	396	2.444	287.88
8	1.862	1.131	453	2.793	376.12
9	2.356	1.257	509	3.142	475.91
10	2.909	1.382	566	3.491	587.52
11	3.520	1.508	622	3.840	711.04
12	4.189	1.634	679	4.189	846.17
13	4.916	1.759	736	4.538	992.88
14	5.701	1.885	792	4.887	1151.54
15	6.545	2.011	849	5.236	1322.09
16	7.447	2.136	905	5.585	1504.29
17	8.407	2.262	962	5.934	1698.21
18	9.425	2.388	1018	6.283	1913.85
19	10.50	2.513	1075	6.633	2121.00
20	11.64	2.639	1131	6.982	2351.28

COAL BINS.

Cubic feet multiplied by 54 will give pounds of anthracite or Cumberland coal, and conversely the weight of a given quantity of anthracite or Cumberland coal in pounds, divided by 54, will give the cubic feet of space required to store it.

EXAMPLE.—How much coal will a bin 10 feet long, 3 feet wide and 7 feet high contain?

Answer.— $10 \times 3 \times 7 = 210$ cubic feet $\times 54 = 11,340$ pounds, or $5\frac{57}{100}$ tons.

EXAMPLE.—What are the cubic contents of a bin large enough to hold an ordinary carload of coal, say $12\frac{1}{2}$ tons?

Answer.—Twelve and one-half tons = $(12\frac{1}{2} \times 2000) 25,000$ pounds $\div 54 = 463$ cubic feet (nearly). Knowing the cubic-foot capacity required, the dimensions are easily calculated by assuming two of them and determining the third, varying the sizes assumed until satisfactory proportions are reached. Thus, in the above we will assume the height to be 7 feet. Dividing 463 cubic feet by 7, we have 66

square feet (nearly), which is the product of the other two dimensions of the required bin. If the bin is to be 6 feet wide, the length will be 11 feet. We will suppose that the length is fixed by the conditions of the place in which the bin is to be built, and that it is 12 feet. Dividing 66 by 12 we have the width— $5\frac{1}{2}$ feet. Therefore the bin, to hold the carload of coal as above, may be 12 feet long, $5\frac{1}{2}$ feet wide, and 7 feet high. Proof, $12 \times 5\frac{1}{2} \times 7 = 462$ (nearly) $\times 54 = 25,008 \div 2000 = 12\frac{1}{2}$ tons. It will be observed that nearest approximate whole numbers have been used in this calculation, just as builders would most likely estimate in practice under similar circumstances.

Bituminous coal may be calculated in the same way, assuming its weight at 50 pounds per cubic foot. Charcoal weighs 18.2 pounds per cubic foot.

WAGES TABLE.

RATE OF WAGES PER DAY.—FOR HOURS.

Hours.	\$1 50	\$1.62½	\$1.75	\$1.87½	\$2.00	\$2.12½	\$2.25	\$2.37½
½	.07½	.08½	.08¾	.09¾	.10	.10¾	.11¼	.11¾
1	.15	.16¼	.17½	.18¾	.20	.21¼	.22½	.23¾
2	.30	.32½	.35	.37½	.40	.42½	.45	.47½
3	.45	.48¾	.52½	.56¼	.60	.63¾	.67½	.71¼
4	.60	.65	.70	.75	.80	.85	.90	.95
5	.75	.81½	.87½	.93¾	1.00	1.06¼	1.12½	1.18¾
6	.90	.97½	1.05	1.12½	1.20	1.27½	1.35	1.42½
7	1.05	1.13¾	1.22½	1.31¼	1.40	1.48¾	1.57½	1.66¼
8	1.20	1.30	1.40	1.50	1.60	1.70	1.80	1.90
9	1.35	1.46¼	1.57½	1.68¾	1.80	1.91¼	2.02½	2.13¾
Hours.	\$2.50	\$2.62½	\$2.75	\$2.87½	\$3.00	\$3.12½	\$3.25	\$3.37½
½	.12½	.13½	.13¾	.14¾	.15	.15¾	.16¼	.16¾
1	.25	.26¼	.27½	.28¾	.30	.31¼	.32½	.33¾
2	.50	.52½	.55	.57½	.60	.62½	.65	.67½
3	.75	.78¾	.82½	.86¼	.90	.93¾	.97½	1.01¼
4	1.00	1.05	1.10	1.15	1.20	1.25	1.30	1.35
5	1.25	1.31¼	1.37½	1.43¾	1.50	1.56¼	1.62½	1.68¾
6	1.50	1.57½	1.65	1.72½	1.80	1.87½	1.95	2.02½
7	1.75	1.83¾	1.92½	2.01¼	2.10	2.18¾	2.27½	2.36¼
8	2.00	2.10	2.20	2.30	2.40	2.50	2.60	2.70
9	2.25	2.36¼	2.47½	2.58¾	2.70	2.81¼	2.92½	3.03¾

WAGES TABLE.

(Continued.)

RATE OF WAGES PER DAY.—FOR HOURS.							
Hours.	\$3.50	\$3.75	\$4.00	\$4.25	\$4.50	\$4.75	\$5.00
$\frac{1}{2}$	.17 $\frac{1}{2}$	.18 $\frac{3}{4}$	.20	.21 $\frac{1}{4}$	.22 $\frac{1}{2}$	.23 $\frac{3}{4}$	.25
1	.35	.37 $\frac{1}{2}$	.40	.42 $\frac{1}{2}$	.45	.47 $\frac{1}{2}$	.50
2	.70	.75	.80	.85	.90	.95	1.00
3	1.05	1.12 $\frac{1}{2}$	1.20	1.27 $\frac{1}{2}$	1.35	1.42 $\frac{1}{2}$	1.50
4	1.40	1.50	1.60	1.70	1.80	1.90	2.00
5	1.75	1.87 $\frac{1}{2}$	2.00	2.12 $\frac{1}{2}$	2.25	2.37 $\frac{1}{2}$	2.50
6	2.10	2.25	2.40	2.55	2.70	2.85	3.00
7	2.45	2.62 $\frac{1}{2}$	2.80	2.97 $\frac{1}{2}$	3.15	3.32 $\frac{1}{2}$	3.50
8	2.80	3.00	3.20	3.40	3.60	3.80	4.00
9	3.15	3.37 $\frac{1}{2}$	3.60	3.82 $\frac{1}{2}$	4.05	4.27 $\frac{1}{2}$	4.50

RATE OF WAGES PER DAY.—FOR DAYS.							
Days.	\$1.50	\$1.62 $\frac{1}{2}$	\$1.75	\$1.87 $\frac{1}{2}$	\$2.00	\$2.12 $\frac{1}{2}$	\$2.25
$\frac{1}{4}$	.37 $\frac{1}{2}$	.40 $\frac{5}{8}$	.43 $\frac{3}{4}$	.46 $\frac{7}{8}$	.50	.53 $\frac{1}{4}$	.56 $\frac{1}{4}$
$\frac{1}{2}$	.75	.81 $\frac{1}{4}$	.87 $\frac{1}{2}$	.93 $\frac{3}{4}$	1.00	1.06 $\frac{1}{4}$	1.12 $\frac{1}{2}$
$\frac{3}{4}$	1.12 $\frac{1}{2}$	1.21 $\frac{7}{8}$	1.31 $\frac{1}{4}$	1.40 $\frac{5}{8}$	1.50	1.59 $\frac{3}{8}$	1.68 $\frac{3}{4}$
2	3.00	3.25	3.50	3.75	4.00	4.25	4.50
3	4.50	4.87 $\frac{1}{2}$	5.25	5.62 $\frac{1}{2}$	6.00	6.37 $\frac{1}{2}$	6.75
4	6.00	6.50	7.00	7.50	8.00	8.50	9.00
5	7.50	8.12 $\frac{1}{2}$	8.75	9.37 $\frac{1}{2}$	10.00	10.62 $\frac{1}{2}$	11.25
6	9.00	9.75	10.50	11.25	12.00	12.75	13.50
7	10.50	11.37 $\frac{1}{2}$	12.25	13.12 $\frac{1}{2}$	14.00	14.87 $\frac{1}{2}$	15.75
8	12.00	13.00	14.00	15.00	16.00	17.00	18.00
9	13.50	14.62 $\frac{1}{2}$	15.75	16.87 $\frac{1}{2}$	18.00	19.12 $\frac{1}{2}$	20.25
10	15.00	16.25	17.50	18.75	20.00	21.25	22.50

WAGES TABLE.

(Continued.)

RATE OF WAGES PER DAY.—FOR DAYS.								
Days.	\$2.37½	\$2.50	\$2.62½	\$2.75	\$2.87½	\$3.00	\$3.12½	\$3.25
¼	.59¾	.62½	.65¾	.68¾	.71¾	.75	.78½	.81¼
½	1.18¾	1.25	1.31¼	1.37½	1.43¾	1.50	1.56¼	1.62½
¾	1.78½	1.87½	1.96¾	2.06¼	2.15¼	2.25	2.34	2.43¾
2	4.75	5.00	5.25	5.50	5.75	6.00	6.25	6.50
3	7.12½	7.50	7.87½	8.25	8.62½	9.00	9.37½	9.75
4	9.50	10.00	10.50	11.00	11.50	12.00	12.50	13.00
5	11.87½	12.50	13.12½	13.75	14.37½	15.00	15.62½	16.25
6	14.25	15.00	15.75	16.50	17.25	18.00	18.75	19.50
7	16.62½	17.50	18.37½	19.25	20.12½	21.00	21.87½	22.75
8	19.00	20.00	21.00	22.00	23.00	24.00	25.00	26.00
9	21.37½	22.50	23.62½	24.75	25.87½	27.00	28.12½	29.25
10	23.75	25.00	26.25	27.50	28.75	30.00	31.25	32.50
Days.	\$3.37½	\$3.50	\$3.75	\$4.00	\$4.25	\$4.50	\$4.75	\$5.00
¼	.84¾	.87½	.93¾	1.00	1.06¼	1.12½	1.18¾	1.25
½	1.68¾	1.75	1.87½	2.00	2.12½	2.25	2.37½	2.50
¾	2.53½	2.62½	2.81¼	3.00	3.18¾	3.37½	3.56¼	3.75
2	6.75	7.00	7.50	8.00	8.50	9.00	9.50	10.00
3	10.12½	10.50	11.25	12.00	12.75	13.50	14.25	15.00
4	13.50	14.00	15.00	16.00	17.00	18.00	19.00	20.00
5	16.87½	17.50	18.75	20.00	21.25	22.50	23.75	25.00
6	20.25	21.00	22.50	24.00	25.50	27.00	28.50	30.00
7	23.62½	24.50	26.25	28.00	29.75	31.50	33.25	35.00
8	27.00	28.00	30.00	32.00	34.00	36.00	38.00	40.00
9	30.37½	31.50	33.75	36.00	38.25	40.50	42.75	45.00
10	33.75	35.00	37.50	40.00	42.50	45.00	47.50	50.00

MISCELLANEOUS MEMORANDA.

- 1000 bricks closely stacked occupy about 56 cubic feet.
 1000 old bricks cleaned and loosely stacked occupy about 72 cubic feet.
 1 foot superficial of gauge arches requires 10 bricks.
 1 foot superficial of facings requires 7 bricks.
 1 yard of paving requires 36 stock bricks laid flat, or 52 on edge.
 Stock or place bricks commonly measure $8\frac{3}{4}$ inches, by $4\frac{1}{4}$ inches, by $2\frac{3}{4}$ inches, and weigh from 5 to 6 pounds each.
 Paving bricks should measure 9 inches, by $4\frac{1}{2}$ inches, by $1\frac{3}{4}$ inches, and weigh from 4 to $4\frac{1}{2}$ pounds each.
 1 yard of paving requires 36 paving bricks laid flat, or 82 on edge.
 1 perch of stone = 1 foot \times 1 foot 6 inches \times 16 feet 6 inches = 24.75 cubic feet.
 1 cord of wood, clay, &c., = 4 feet \times 4 feet \times 8 feet = 128 cubic feet.
 1 chaldron = 36 bushels, or 57.25 cubic feet.
 1 cubic foot of sand, solid, weighs $112\frac{1}{2}$ pounds.
 1 cubic foot of sand, loose, weighs 95 pounds.
 1 cubic foot of earth, loose, weighs $93\frac{3}{4}$ pounds.
 1 cubic foot of common soil weighs 124 pounds.
 1 cubic foot of strong soil weighs 127 pounds.
 1 cubic foot of clay weighs 120 to 135 pounds.
 1 cubic foot of clay and stone weighs 160 pounds.
 1 cubic foot of common stone weighs 160 pounds.
 1 cubic foot of brick weighs 95 to 120 pounds.
 1 cubic foot of granite weighs 169 to 180 pounds.
 1 cubic foot of marble weighs 166 to 170 pounds.
 1 cubic yard of sand weighs 3037 pounds.
 1 cubic yard of common soil weighs 3429 pounds.

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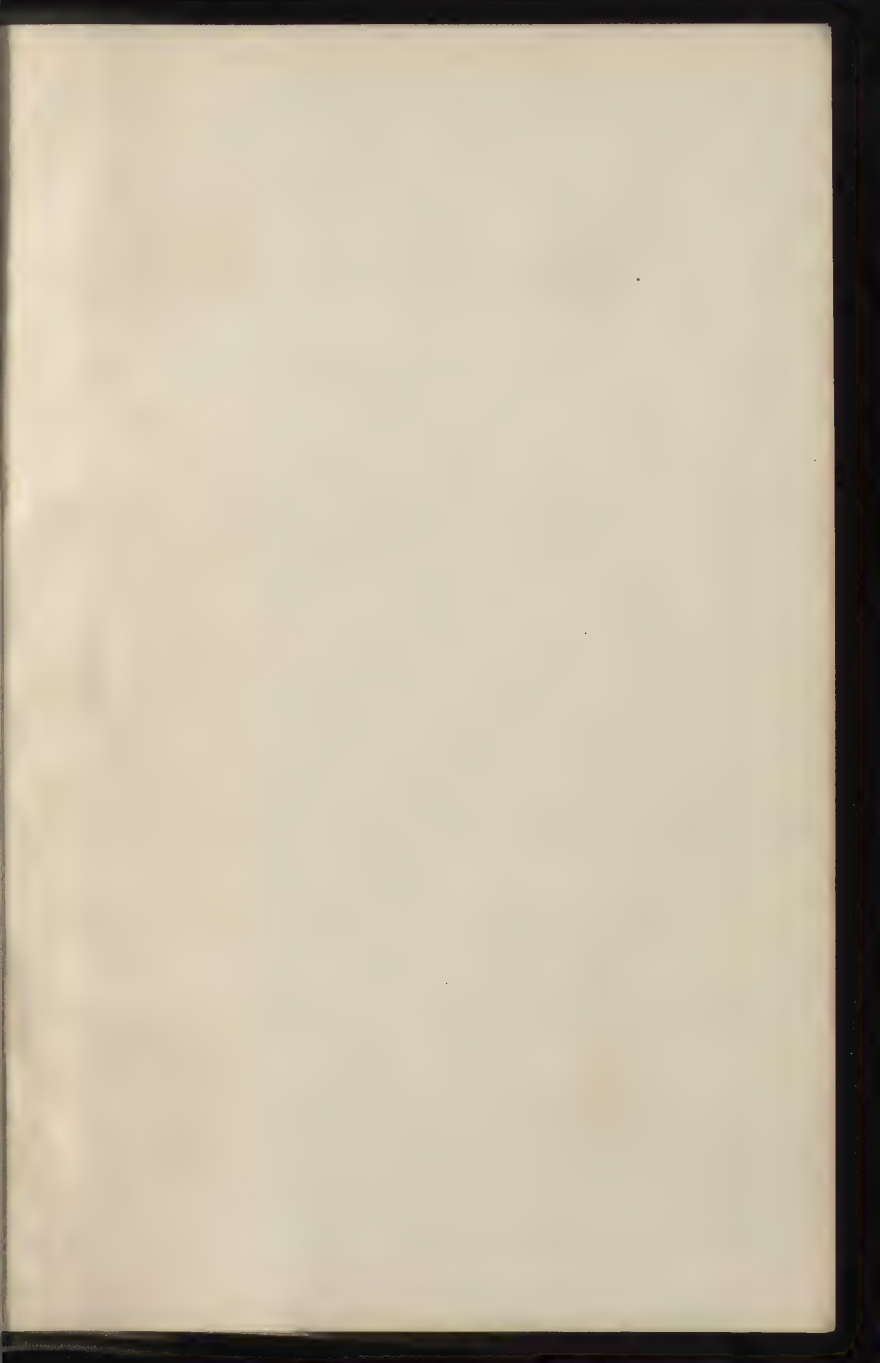
ERRATA.

For sixteenth, seventeenth and eighteenth lines on page 70 read as follows:

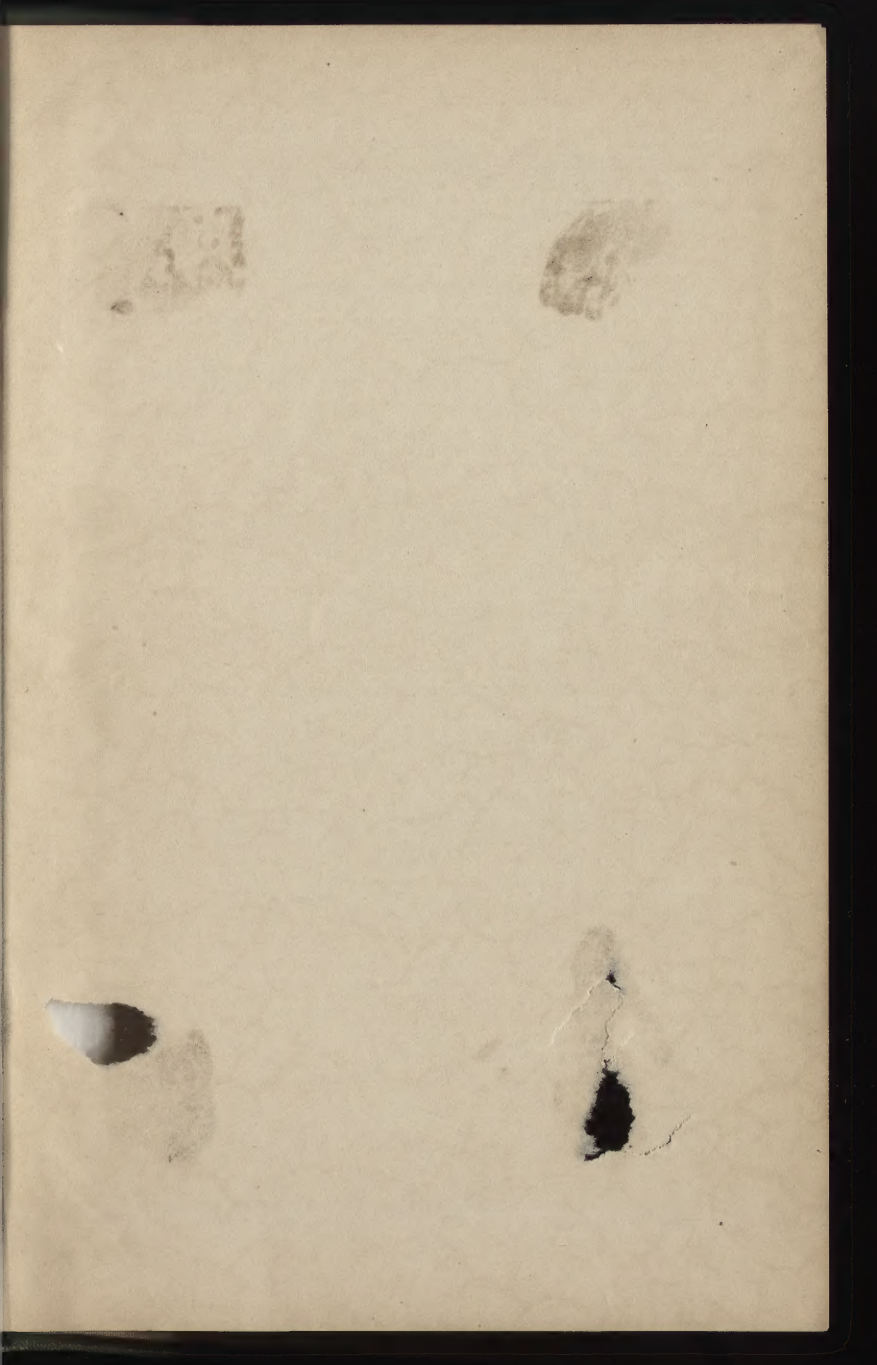
Cubic Inches \times .00433 = U. S. Gallons.
 Cubic Inches \times .000465 = U. S. Bushels.
 Cubic Inches \times .00058 = Cubic Feet.

For seventh and eighth lines on page 71 read as follows:

Cubic Feet \times 7.478 = U. S. Gallons.
 Cubic Feet \times .80352 = U. S. Bushels.







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